1859 FIFTY-EIGHTH YEAR 1916

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VOLUME CV., No. 20. Whole No. 3062. NEW YORK, MONDAY, NOVEMBER 13, 1916. Subscription, $3 Per Year. $4 Canada. $5 Foreign.

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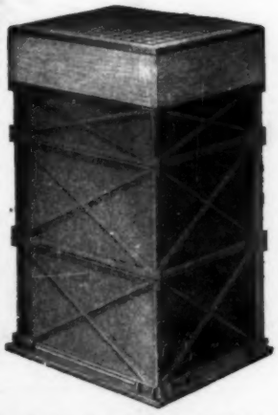

Ideal Roadway Box—Square Model

Ideal Roadway Box—Round Model Sectional View

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KOPPERS

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The most efficient method of carbonizing coal is in KOPPERS OVENS and the best coke and by-products are produced by this process.

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1859 FIFTY-EIGHTH YEAR 1916

AMERICAN GAS LIGHT JOURNAL

VOL. CV., No. 20. NEW YORK, NOVEMBER 13, 1916 WHOLE No. 3,062.

Ratio of Electrically-Caused Fires to Those Due to Gas in Ten States Slightly Over 2½ to 1

This would be Increased to 10 to 1 Were Relative Number of Services Taken into Consideration—Figures Conclusively Prove Superiority of Gas Over Electricity as a Fire Hazard, though Latter is Not Held to be Dangerous Source of Energy from Such Standpoint as Compared to Other Fuels and Illuminants

By ROBERT FFRENCH PIERCE

In the selection of lighting appliances, fire-risk is entitled to much more consideration than it ordinarily receives. The consumer usually takes the position that as long as the illuminants under consideration are placed upon the same basis by fire insurance companies in fixing premiums, the systems may be regarded as equally desirable from the standpoint of fire hazard.

If the losses suffered by reason of fire might be regarded as limited to the physical value of plant and material destroyed, this would be a logical conclusion, but this is not the case. The loss of business incurred during the period of rebuilding and getting the concern in running order, loss of life and the damages awarded for losses of employees' lives resulting from defective safety appliances are of such importance that the number of cases in which the insured would willingly suffer fire for the sake of insurance may be regarded as negligible.

Proper To Point of Disadvantages of Competing Sources of Energy

It is often considered that insurance premiums are accurately proportioned to the probability of fire under the conditions specified, drawn from the statistics covering a wide range of time and territory, and may be regarded as an accurate indication of fire hazard. This is but an approximation of the truth. Practical and business considerations make it impossible to incorporate any but the most general features of construction into the rules governing the fixing of premiums.

It is a well known fact that many conditions of demonstrated influence in the causing of fires are ignored altogether in computing the rates to be charged for fire insurance, and the proper presentation of these facts is a legitimate expedient in the sale of any system of distribution of energy for light, heat or power that may be shown to enjoy measurable advantages in this respect.

It is quite as proper for the salesman of electric heating to draw attention to the advantage of electricity over coal as regards fire risk, as it is for him to point out the convenience of electricity, or any other advantageous feature. Any fact involving the customer's interests in any way whatsoever is a suitable, proper and legitimate subject for persuasive argument.

For many years the discussion of fire hazard and its influence upon the selection of sources of central station energy supply has been relinquished, purely by default, to our electrical competitors. It seems to have been assumed that the advantages lay with this source of energy and that discussion would only serve to disclose a naturally weak position. This condition has existed for so long that undoubtedly all of the general public, and probably most of the gas men, believe in the substantial truth of the oft-repeated

CAUSES	Maine		Massachusetts		Virginia		(1914) Ohio		Indiana		(1915) Illinois		Michigan		Minnesota		Iowa		(1916) Nebraska		Total
	No.	Loss	No.	Loss	No.	Loss	No.	Loss	No.	Loss	No.	Loss	No.	Loss	No.	Loss	No.	Loss	No.	Loss	
GAS:																					
Explosion							127	$187,496	28	$948					16	$20,561	2	$1,325			
Open Jet	11	$4,182					105	45,797	10	1,229					6	720			2		
Stove															10	21,120	3	355	6		
Iron																			3		641
Ignition of escaping gas			42	$3,842													6	457			
Meter																	1	2			
Not otherwise specified					16						149	$43,107	135	$990,379							
ELECTRICITY:																					
Wiring							162	$495,126	156	$3,687,650			404	$3,682,180	102	$266,095	73	$229,307	42		
Stove	1	$33															6‡	1,154‡			
Iron																	6	3,201	4‡		1,616
Not otherwise specified	58	$123,507	216	$10,313,474	34						352	$448,774									
GASOLINE:																					
Explosion	39	$110.08					179	$101,552	89	$586,695					56	$119,601	91	$62,787	26		
Open Jet																					
Lamp															4	60,225					2,079
Stove	2	88													18	10,209	93*	$60,124*	25		
Not otherwise specified	14	$70.52	276	$4,185,810*	20				67	$129,225	788*	$502,928*	271	$949,534			21	21,349			
KEROSENE:																					
Explosion									18	$34,300			a	a	6	$4,080					
Lamp							79	$3,339	62	188,420	326†	$53,613†			38	29,960			8		
Stove	17	$78.79					39	23,575	63	130,175					29	28,155	b	b	34		800
Not otherwise specified	68	304.80		13																	
Miscellaneous													c169 d266	$663,243 1,671,617							435

* Includes kerosene and other volatile oils
† Includes all "open lights." No reference to gas.
‡ Includes gas irons or stoves.

a Not separately specified. See Miscellaneous.
b Not separately specified. See also gasolene.
c Explosions not otherwise specified.
d Open fires and lights not otherwise specified.

statement that electricity is of all sources of energy the least likely to introduce fire-hazard. At least, the subject has been sedulously avoided by the advocates of gas although enthusiastically and emphatically reiterated both by spoken and printed word, by the exploiters of electricity.

Result of Investigation

With the object of ascertaining just how much of the claims made by our opponents is based upon actual fact, and how much upon mere fancy invested with more or less authority by virtue of undisputed affirmation, the writer collected the reports of the fire marshals of ten states from which detailed records are available, and was surprised to find that reports instead of merely indicating substantial equality between gas and electricity as fire hazards, actually proved a noteworthy superiority for gas, particularly when taking into account the fact that gas is much more widely used, as is shown by the greater number of meters in use—a fact which is not indicated in the reports referred to.

A digest of the report (as regards gas, electricity, gasoline and kerosene) is printed in table form on the preceding page.

The figures speak for themselves and scarcely require elaboration. In view of the fact that there are probably at least four gas meters to each electric meter in the territories represented, the ratio of electric fires to gas fires (1616 to 640, or slightly over 2½ to 1) should be multiplied by at least 4, making the actual ratio 10 to 1 based upon equal use.

The comparative prevalence of gas fires and explosions in Ohio is undoubtedly due to the widespread use of natural gas and the carelessness attendant upon the use of a very cheap fuel.

It is not intended to convey the impression that electricity is a dangerous source of energy from the standpoint of fire hazard. On the contrary electricity is, with the exception of gas, probably the safest of fuels and illuminants, although far inferior, as shown by the official records, and this condition exists in spite of the more vigorous and better developed standards of construction and installation imposed upon electrical apparatus by the Fire Underwriters.

It should be understood that in some cases fires originating from gas are grouped with those resulting from kerosene, coal fires, etc., and cannot be separated. Figures from states in which separate results are available indicate that in all probability the number of fires due to gas thus represented is negligible. As a general statement of conditions, the above table is believed to be free from grounds for substantial or serious criticism.

Like the air—vitiation fallacy, the gas fire-hazard bugaboo vanishes into thin air when punctured by an investigation of facts. Moreover, the facts prove the precise opposite of the accepted allegations. Such differences as do exist are altogether in favor of gas, and they are advantages which affect the interests of every gas user.

Greatest Promise for Future Expansion of Gas Industry Lies in Small Nearby Communities

Higher Pressures the Means of Taking Advantage of Them— Advantages of Locating Works with Reference to Manufacturing Requirements Rather than with Regard to Being Near Center of District Served

By J. E. BULLARD

There are in this country more than 3,300 communities supplied with electricity for cooking purposes at rates of five cents or less per kw. hr. Many of these communities are suburban to large cities, and often the granting of the special rate has been brought about by the fact that unless the electric rate is made low enough to make electric cooking possible a gas company will enter the territory.

Electric companies have been able to enter and to develop communities before the gas company has been able to do so, because, for years it has been the common practice of electric companies to transmit current at very high pressure. The pressures now in common use for inter-urban transmission vary from about 10,000 volts to 100,000 volts. Considering a 2-ounce gas pressure as equivalent to an electric pressure of 50 volts, this corresponds to gas pressures of from 25 to 250 lb.

It is not at all hard to imagine how many more communities would now be supplied with gas if during the past fifteen years it had been common practice to distribute gas at pressures as high as this rather than making from 25 to 40 lb. the limit. It is also easy to imagine how *much* more competition the electric light companies would have been obliged to meet.

Obstacles as to Question of Gas Works Location

Another reason why some communities have no gas supply lies in the fact that no location for a gas works can be found that will satisfy both the citizens and the gas company. Since high pressure distribution makes it possible to supply several communities from one works this obstacle is very readily overcome. In fact it is not even necessary to build gas holders in every community served with a high pressure system. This is especially true if the high pressure is carried to the premises of the consumer and there reduced by individual governors.

There are localities where whole counties are served from high pressure systems with no holders except at the works. When small communities are served this is an item of expense that may have a very marked effect upon the rates charged and the net profit to the company.

The fact that high pressure distribution makes it possible to concentrate the manufacture of gas in fewer gas plants is also of immense importance. This advantage added to the possibility of more favorably locating the works enhances the financial advantage of the use of higher distribution pressures.

With high presure, a few miles of main does not matter so much as in the case of low pressure where the works must be located with a view to keeping the pressure as uniform as possible, and of making the large main lines as short as possible.

High pressure permits of locating the works with a view of manufacturing the gas as cheaply as possible. This means that the works can be located where land is cheap, transportation good, water for cooling, condensing, and cleaning readily obtainable at low rates and the manufacturing can be carried on at the least possible cost to the company and the least possible annoyance to the communities served.

Gas-Works at Tidewater

There are many gas works situated short distances inland that could be located to advantage to the gas company at tidewater, and the gas pumped to the communities served. This, in many cases, makes the gas cheaper delivered to the consumer than when it is manufactured in the present works.

There are other communities where very decided advantages can be gained by concentrating the gas making into one plant favorably located, and shutting down the other plants which serve the district under consideration. Each year the advantage of this plan is becoming more and more apparent so that as time goes on we can expect to see the average size of gas works growing larger and larger, and the number in comparison to the communities served growing smaller and smaller. This and the custom of locating gas works at tidewater, however, cannot become as common as it should until even higher pressures than are in use to-day become standard practice.

If the gas industry was now in a position to distribute gas at pressures of from 100 to 200 lb., there is every reason to believe, judging from the progress that is being made by electric companies, that within the next ten years the gas business would at least double in size. At the present time it is losing an immense sum of money each year to the electric light industry, and the oil companies. It is losing this money simply because the practice of low pressure distribution has confined it to the larger and more densely settled centers of population and has prevented it entering the smaller and sparsely settled but rapidly growing communities where there is an unbelievable amount of profitable business to be had.

The fact that electric companies have been able to enter such communities on practically nothing but a lighting load and that they have been able to prosper while giving a 25-hour service under these conditions indicates how great the profit would be to gas companies which could develop cooking and heating loads as well as lighting loads. As the case now stands, however, most of these communities have already been entered by electric companies, the lighting load has already been developed and work is well under way to develope electric heating loads. It, therefore, is necessary that gas companies enter this field within a very short time or they will meet the keenest competition and experience as much difficulty in developing cooking and heating loads as they are now experiencing in building up lighting loads.

Much of Novel and Experimental Work Done in Small Communities

It must always be borne in mind that it is not in the large cities that much of the novel and experimental work is done with electricity. It is not in the cities that we must always expect to see the best work done along the line of lighting and cooking. Rather it is in those small communities where there is no gas supply, and where the people are glad to give anything a trial if it promises to free them from dependence on coal, wood and oil.

The writer lives on a short street in a suburban village that boasted of an electric lighting service for some ten years before it was entered by a high pressure gas line. There are fourteen houses on this street. Twelve of them are lighted with electricity. Eleven of them have gas ranges, but there is only one where gas is used for lighting from more than the one burner over the gas range that was installed free by the gas company.

A surprising number of electric cooking utensils, including ranges, had been installed in this district on a 15 cent electric rate before the gas supply was assured. The people in the district have become so accustomed to the use of electricity that the electric company, any time it decides to put into effect an electric cooking rate, will not experience as much difficulty in building up a very substantial cooking load as the gas company has experienced in building up a gas lighting load.

Greatest Promise for Future Lies in Small Communities

It is in these small communities that we may look for the greatest future in the gas business. In these we find the commercial end of the business developed to a very marked degree. We also find the smaller companies trying out new ideas and doing more than their share to accelerate the growth of the industry.

It is in these small communities that new ideas can be put into operation without such serious effects if they prove wrong as would be the case in a large city. Small communities have proven excellent laboratories for the electric light industry and there is no reason why they should not be made to serve the same purpose for the gas industry.

The gas business is often charged with being too conservative. This charge could hardly be made if all the small communities which it is even now possible to serve with high pressure gas had a gas supply and all the new ideas suggested were actually tried out in practice in these small undertakings before they were adopted on a larger scale in the big cities.

The more small communities served and the more attention given to the methods tried out in these communities the greater will be the progress in the gas business. The only way these communities can be served in a satisfactory manner, however, is by the adoption of very much higher distribution pressures than are now considered standard practice.

To Sell or Not to Sell

Merchandising is the big commercial game of to-day. No commercial enterprise is exempt from its rules. It applies equally to the manufacturer of paper clips and the college president who is trying to put his university on a paying basis. Salesmen, show windows, correspondence and advertising are only ways of merchandising. Its first principle is "Take your goods to the consumer and make him want them."

Gas, gas appliances and gas service are the "goods" of the gas man and his problem in its commercial aspect is to merchandise these products. If he waits for people to come to him, to ask for a new type of gas range or metal-melting furnace, if he modestly hides his gas lamps under bushel baskets, he is showing a misconception of his whole business. He, like all other merchants, must take his wares to the people and create in them a "desire-to-own." He must use the means which have been found effective—trained salesmen, well-planned windows with a selling idea, good business letters and wide-awake advertising.

—*Monthly Bulletin of the National Commercial Gas Association.*

Ability of Artificial Fibre Mantle to Withstand Shocks After Long Period in Service Little Less Than It Was Originally

E. L. Knoedler Discusses Various Mantle Fibres—Reminds that Process of Gas Mantle Manufacture is That of Replacing Fibre With Salts of Rare Earths and That Therefore Mantle is Exact Reproduction in Rare Earth Oxides of What Fibre Was

The flexible or Rag mantle is not new to those who are acquainted either with pressure gas, or with pressure gasoline lighting. To be sure, pressure gas lighting has been very slow in developing in the United States, but in Europe it finds wide and successful application. On the other hand gasoline pressure lamps using rag mantles are very numerous and popular in this country, particularly in the great Northwest.

E. L. KNOEDLER

From time to time statements have been made and lurid advertisements have appeared, announcing successful flexible mantles for use on ordinary gas burners, but as a matter of fact these statements have been largely those of fakirs, whose wares have been advertised and exploited as "Unbreakable Mantles." During the past few years, first one, then another, of these mantles has appeared, only to disappear again as does every article which fails to impress the consuming public as measuring up to the claims made for it.

These much advertised "Unbreakable" mantles have been without exception the very cheapest and flimsiest which could be made and still hold together until in place on the burner. No other construction would permit of sufficient expansion by the flame of the ordinary gas burner to produce even the remotest resemblance to a gas mantle.

The use of medium grade, or more often of low grade cotton or ramie threads, impregnated with only the smallest possible quantity of Thoria, has resulted in such a weakened structure that the mantles soon fell to pieces. Again, as a rule, the shape of the mantles has not been favorable to the production of maximum candle power.

Finally, if the shape of the mantle was satisfactory, and if by chance it was able to remain in service for any length of time, the candle power was found to deteriorate very quickly and the color to change from yellow to greenish white, after burning only a relatively short time. These changes were due in large measure to the poor quality of the base, or to the small quantity of light producing materials present.

Several features in the use of artificial fibre in the manufacture of gas mantles, have made possible the development of a successful limp or rag mantle, asserted E. L. Knoedler, general superintendent of the Welsbach Company, of Gloucester, N. J., in his paper on "Recent Developments in Incandescent Gas Mantles," presented at the joint meeting of the Illuminating Engineering Society and the American Electro-chemical Society—New York Sections—held in New York City, Nov. 9.

Success of Mantle Depends Primarily Upon Two Factors

In this mantle the shaping or hardening process has been greatly simplified, and the use of the improved base material has almost entirely eliminated the danger to the consumer of a manufacturing loss.

The mantle is unique in a number of ways, but its success depends primarily upon two things. First, upon the fact that it can be used only upon a burner designed and constructed for this particular mantle. Second, upon the construction of the mantle itself and the character of the materials used in its manufacture.

The burner design is such as to produce a perfect gas and air

mixture, with any gas at the gas pressures ordinarily available; a mixture which is uniform and which does not contain the lean and fat streaks so often present in gas mixtures provided by the average burner.

The flame produced by this burner is very hot, containing more primary air than usual and therefore requiring less secondary air for complete combustion. This makes for perfect combustion with almost complete absence of the tendency to carbonize.

This burner has a wide operating range and will permit of considerable over and under adjustment. It will likewise continue to operate satisfactorily when the gas pressures vary so as to seriously affect the majority of other gas lighting burners.

The mantle itself is unique in many ways. In the first place it is made from artificial fibre, popularly known as artificial silk. It is small in size, being only ⅞ in. in length and ¼ in. in diameter and it is of the totally closed variety, having no vent at the top as have all the older types of both upright and inverted mantles.

Process of Manufacture of Fibre

Artificial fibres are made by treating cotton or other cellulose fibres in such a way as to convert them into a thick viscous liquid which is forced under high pressure through fine dies, into a solution which fixes the thin wire-like strands thus formed.

There are several satisfactory methods for making these artificial fibres, but the best product from the standpoint of the mantle industry is made by the Viscose process.

These fine artificial threads have important advantages over natural fibres, for mantle making purposes. In the first place the physical and chemical properties are almost completely under control, so that fabrics made from artificial threads are incomparably more uniform in their essential physical and chemical features than are those made from the natural fibres. Also the artificial thread used, while thin, is very strong and is capable of substantially heavier impregnation than either cotton or ramie threads, which makes for great physical strength and elasticity.

Cotton fibre varies from 1 in. to 1½ in. in length and is tubular in form. Ramie fibre, also largely used in the manufacture of mantles, is several inches in length and flattened or husk shaped.

Both of these fibres are more or less hollow, and are often distorted in shape, broken, or otherwise imperfect.

Contrasted with these is the artificial fibre, of almost infinite length, solid like a wire, uniform in cross section, and of predetermined diameter, in fact made to suit the purpose to which it is to be put, and it is easy to see why there should be a difference in the finished products made from such different raw materials.

Again, the chemical properties of the fibres are of utmost importance in connection with the quality of the goods. The chemical constituents of the natural fibres vary with the different staples, with the character of the ground upon which they grow and with the methods of working in the various mills where the threads are spun and bleached.

These variations render necessary very comprehensive bleaching and washing processes in order that the chemical differences may be so leveled down as to produce a uniform product.

In the case of the artificial fibre many of the chemical impurities have been removed during the manufacturing process, and those which remain have been uniformly distributed throughout the whole batch of material so that all the fibres are of identically the same chemical composition.

In one case we have to work with the natural fibres as nature gives them to us, in the other we deal with a material which can be so fashioned by a controllable manufacturing process as to give us exactly the kind of material we require.

In considering the bearing of these facts, it must be born in mind that the process of manufacture of any gas mantle is essentially that of replacing the fibre with the salts of the rare earths and that the mantle is therefore an exact reproduction in rare earth oxides of what the fibre was.

The Cotton Mantle

Soft and flexible initially the cotton mantle, after a few hours of burning begins to grow hard and brittle. This condition is exaggerated as the period of service lengthens out. After some time the mantle becomes very hard and is rather easily broken by shock. This change in temper is accompanied by a shrinkage in size, which may reduce the area of the working surface as much as 10 per cent or 15 per cent in 100 hours.

As the surface grows smaller, it grows proportionately denser, and less effective as a light producing body. The openings between the meshes of the mantle structure are reduced in size and the discharge of the products of combustion through the mantle becomes increasingly difficult.

Gradually the air inflow is throttled and combustion becomes less and less perfect, resulting finally in the worst cases, in carbonization and breakage of the mantle.

In any case these changes in the cotton mantle produce a substantial drop in the candle power during the first 50 or 100 hours of service, with a further, slow but certain reduction as the mantle continues in use.

Finally, not only has the amount of light been considerably reduced, but the color of the light has changed from an agreeable mellow color to a greenish white.

These phenomena take place in every cotton mantle in a shorter or longer period of time, but they proceed with special rapidity in a mantle which has been skimped during manufacture either by the use of inferior cotton, or by improper density of impregnation.

The Ramie Mantle

Ramie mantles are initially flexible like cotton mantles, although somewhat harder in texture. Like cotton mantles, they also change on burning, from a flexible structure to one which is hard and brittle.

If anything the ramie mantle becomes more brittle and less able to withstand the shocks to which it is subjected in service, than does the cotton mantle.

While in the matter of physical strength the Ramie mantle is thus much like its predecessor the cotton mantle, in the matter of shrinkage it is greatly superior. For this reason it has become very popular when made in the inverted style. On this type of burner shrinkage of the mantle is a particularly serious matter, as small derangements in adjustment are likely to cause carbonization and mantle breakage.

The candle power life of the ramie mantle like the shrinkage, shows great improvement over the cotton mantle, but even at best the results are not all that could be desired.

It is characteristic of both these mantles, that the fine filaments which cover their working surfaces pick up and hold the mineral dust which is drawn into the burner with the air supply. This dusting of the incandescent filaments with siliceous matter probably contributes materially in hastening the depreciation of the mantles.

The color of the ramie mantle also changes slowly as the mantle continues in service.

The Artificial Fibre Mantle

Artificial fibre mantles in service appear to undergo no change in physical condition, maintaining their strength and elasticity over long periods of time. They never become hard and brittle and their ability to withstand shocks after a long life of service seems to be almost as great as it was initially.

The physical strength of these artificial mantles is surprising. They will withstand many times the amount of rough treatment required to destroy the best cotton or ramie mantle. They do not shrink in the slightest degree even after many hundreds of hours in use, but remain perfect in shape, and adapted to the flames to which they have been adjusted.

One of the most remarkable features about the artificial silk mantle is the fact that during the first few hundred hours the candle power actually shows an increase, which often amounts to 5 per cent or 6 per cent. Following this there is a very slow depreciation of candle power, but even after 1,000 hours of service it will usually be found that the mantle is giving as much light as it gave in its initial test.

The color of the light given by silk mantles is likewise very stable in its quality, the change in color being almost imperceptible even after long periods of use.

Light Weight Necessary

We have observed that light weight is necessary if the limp mantle is to be properly shaped on the low pressure gas burner, but light weight in a gas mantle is not compatible with either strength or sustained candle power.

Here artificial silk supplies the deficiencies. These fibres, even though made very fine and light, are yet by the nature of their structure able to impart great strength to the mantle. The use of many such very fine fibres give a working surface of large area, hence high candle power. Sustained candle power and the absence of shrinkage complete the list of features necessary to a high grade and successful article.

Up to the present time it has been found most practicable to make this new mantle in a relatively small size, and to so construct the burner that it takes three mantles instead of one. This has several important advantages, one of which is the fact that the small mantle is light in weight and small in area and therefore much stronger proportionately than it would be if of larger size. The shortening of the mantle greatly reduces the liability of breakage around the ring, as it not only reduces the load carried by that part of the mantle which is tied fast to the ring, but it also minimizes the tendency of the mantle to whip off from its solid fastening.

The proper shaping of this mantle on the burner takes place with greater certainty than it would if the mantle were of larger size. This point will be seen to be of importance, when it is remembered that the shaping is not carried out in the factory at the hands of an expert, but that every customer must do this work for himself.

The maintenance man who must carry and handle large numbers of mantles in the course of a day's work will especially welcome this change in size.

The use of three mantles on a burner instead of one, has the advantage that if one mantle is broken the lamp does not go out of commission, but still continues to give a large amount of light.

As we observed before, this mantle is of the totally closed variety, there being no vent at the top through which a portion of the gases may escape. All the burning gases must pass through the mantle and be effectively utilized in the production of light. The mantle holder itself is threaded and screws tightly on to the burner nozzle, an advantage where there is much vibration.

These new mantles are uniformly and brilliantly illuminated over their entire surface, even in the zone immediately adjacent to the mantle ring. Their intrinsic brilliancy is higher than that of any low pressure mantle heretofore developed and from the results so far tabulated their useful life appears to be greater than that of any other gas mantle in common use to-day.

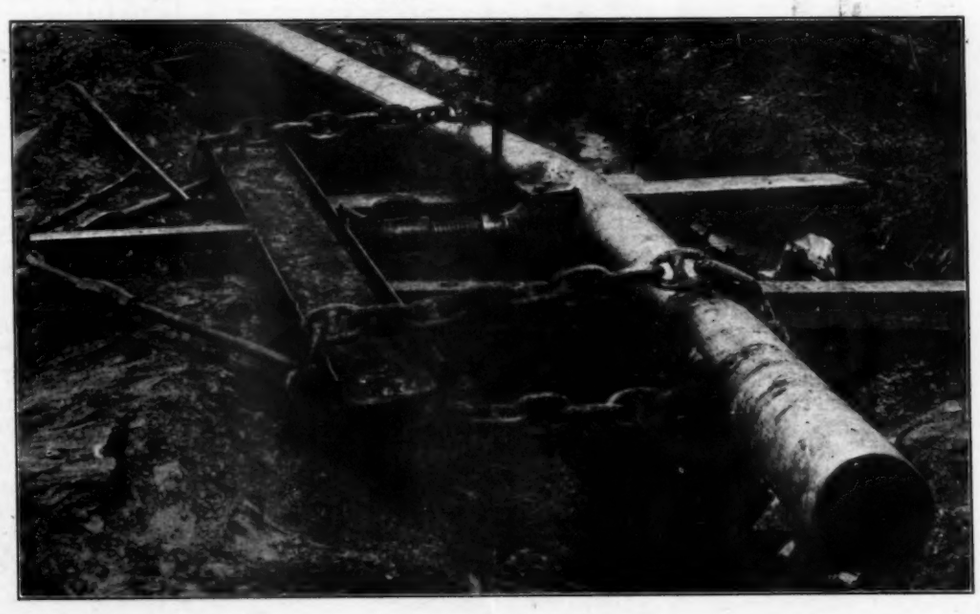
Simple Machine Lowers Cost of Pipe Bending

Has Proven Itself Especially Useful in the Laying of 8-In. Steel Pipe —Idea Suggested by G. W. Savage and Machine Described by Charles Wilde

A bending machine which has proven to be of the greatest assistance in laying 8-in. pipe has been devised by engineers of the Philadelphia Suburban Gas & Electric Company to facilitate such work. The machine, as described by Charles Wilde, engineer of mains for the company, in a paper presented at the recent annual meeting of the American Gas Institute, is a very simple arrangement, consisting of a 10-in. I beam, 10 ft. long, braced with 1¼-in. tie rod, two ¾-in. chains 8 ft. long, and an ordinary 20-ton screw jack and block.

The operation of this machine is quite simple and requires only a minimum of labor. To operate, all that is necessary is to link the chains around the pipe and I-beam by means of a slip link, place the jack and pipe block in position between the pipe and the beam, then by the force of the jack, make the bend. If the bend required is only a slight one, it may be made without any shift of the machine. If it be a bend of any considerable extent the machine should be shifted one way or the other, bending the pipe a few degrees until the required bend is made.

With this machine four men can make a bend in an 8-in. pipe, depending, of course, upon the radius and degree of the bend required, in from a half to two and a half hours, or a labor cost of from fifty cents to two dollars and fifty cents per bend.



To make the same bend—when possble to be made in the old way—would require about twenty-five men, who would never lose less than half an hour from their regular work, which would mean a minimum cost of three dollars and thirteen cents ($3.13), and would often require twice this time, resulting in a labor cost of six dollars and twenty-six cents ($6.26).

In addition to the saving in labor cost, another and very great advantage of an outfit such as described above, is that the bends may be made in advance of the actual main laying, thus assisting very materially in the progress of the work. The device is the result of a suggestion made by G. W. Savage, superintendent of distribution for the Chester district of the company.

Columbia Gas & Electric Company Files Statement

When the Columbia Gas & Electric Company's application for listing of $49,948,700 of its capital stock on the New York Stock Exchange was made, it was accompanied by a full statement of assets and liabilities, copies of which were printed and now are in circulation.

The outstanding funded debt of the Columbia Company, as of July 31, 1916, is given as follows: $13,248,000, first mortgage gold bonds, and $2,617,168.23 debentures, both bearing 5 per cent. Of the bonds outstanding, $2,303,000 are owned by the Union Gas and Electric Company.

The following table shows the outstanding funded obligations of controlled companies:

Cincinnati Gas and Electric 5%	$4,500,000
Cincinnati Edison Electric 5%	1,500,000
Cincinnati Gas Transportation 5%	3,669,000
South Covington and Cinti. Ry. 6%	150,000
Newport and Dayton Ry. 6%	100,000
Licking River Bridge 5%	185,000
C., N. & C. Ry. first 5%	2,750,000
Do, second 5%	694,000
Union Light, Heat and Power 4%	1,561,700
Do, refunding 5%	200,600
United Fuel Gas 6%	7,932,500
Total	$23,242,800

This makes the total funded obligations of all companies $39,107,968.

The statement sets out all the gas, oil and street railway properties and pipe lines owned and controlled, and all the franchises held in cities of Kentucky, West Virginia and Ohio.

The consolidated income account of the Columbia and Union Companies for the year 1915 shows total assets of $72,205,029 and a surplus of $1,113,772. For the seven months of 1916, ended July 31, the assets are given at $70,516,086 and the surplus at $1,619,657.

Considerable Reliance May Be Placed on Cracking Data as Furnishing a Correct Means Valuating Gas Oils

Color Offers but Little Indication as to Real Characteristics—Odor Also Not of Much Value as an Index—Specific Gravity Cannot be Depended Upon to Furnish Required Knowledge

In order to insure the most economical use of oil in carbureted water gas manufacture it is of prime importance that an extensive study be made of oils themselves, as well as of the conditions which affect their utilization. The need of such an investigation at the present time is paramount, because of the existing high prices in the oil market. The adoption of numerous new processes for the production of gasoline has exerted a detrimental influence on the quality of gas oils, and impaired their efficiency as enriching mediums for water gas. While much has been written concerning petroleum oils and hydrocarbons in general, the literature which serves as an aid in the practical identification of valuation of gas oils is very scant, stated R. C. Downing and E. F. Pohlman in their paper on "A Study in Gas Oils"—from which the following has been abstracted—presented at the recent annual meeting of the American Gas Institute.

Tests for Obtaining Understanding of Oils in General

The following tests are of value in obtaining a better understanding of oils in general. Those pertaining to physical constants are: color, odor, specific gravity, refractive index, surface tension, viscosity, flash and burning points, heating value, and fractional distillation. Those depending upon chemical characteristics are: Ultimate analysis, sulphur content, absorption with sulphuric acid, absorption with fuming sulphuric acid, bromine number, and formolite number.

The great difficulty in making use of these tests lies in the fact that a basis of comparison is not usually available. One does not always know how a given oil has behaved under operating conditions, although considerable time may have been spent in analyzing such an oil. However, when it is possible to actually decompose or gasify the oil on a small scale in the presence of blue gas, the sperm and heating value of the gas made, together with the quantity produced, furnish an excellent idea of the value of the oil. In addition to this, a basis is provided with which it is possible to compare and determine the value of the other tests made on the oil.

It is essential that when such a basis is employed that the laboratory device used should give results somewhat comparable to those obtained in practice. The temperature of cracking, time of contact of the oil vapors with the heated walls, size of the apparatus, amount of oil used per thousand cubic feet of gas made, and the quality of blue gas used all exert a considerable influence on the result obtained. The failure of different investigators to consider all of these conditions has resulted in a wide range of results. The data presented in this paper was obtained by using a 2 in. tube as the cracking medium, heated uniformly over a length of 42 in. The oil cracked was of the mid-continent type, the analysis of which is shown under the heading K in Table I. This oil was introduced into the cracking tube at the rate of 5 gal. per 1,000 cu. ft. of gas made. At this rate the time of contact of the oil vapors in the machine approximated 5 seconds.

Description of Apparatus Used

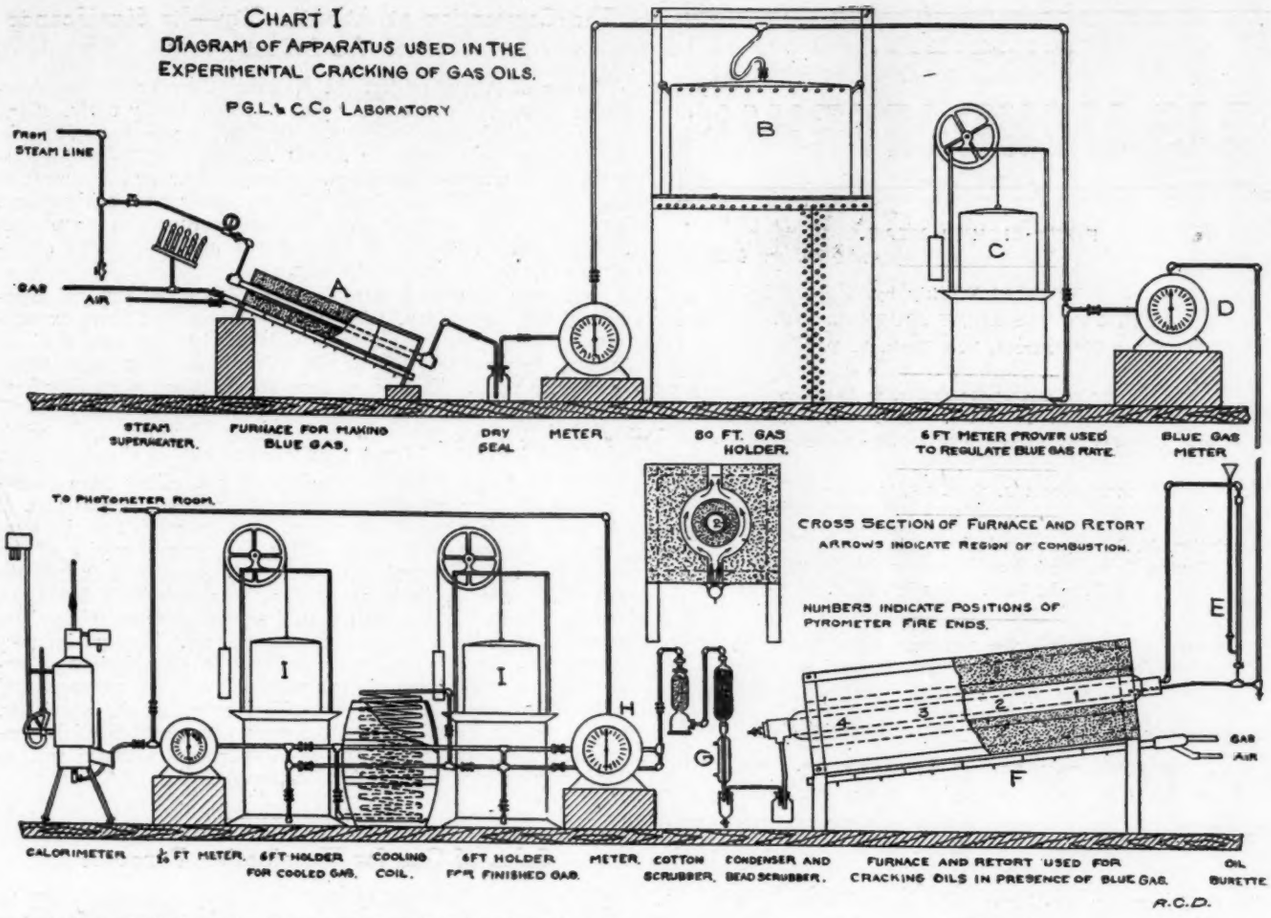
Chart I is an illustration of the apparatus used. The method of operation was briefly as follows: Blue gas was made by passing steam through a bed of finely crushed coke, contained in an iron pipe and heated to incandescence in the furnace *A*. *B* is the storage holder for the blue gas, from which it is drawn into the smaller holder *C*. Here the pressure can be increased sufficiently to force the blue gas at the desired rate of 0.2 cubic foot per minute through the cracking furnace *F*, the scrubbing apparatus *G*, and the meters *D* and *H*. The temperature of the furnace *F* can be

TABLE I.

CHEMICAL AND PHYSICAL PROPERTIES OF VARIOUS OILS TESTED.

KIND OF OIL	I Color	II Transparency	III Specific Gravity.	IV Degrees Baumé.	V Viscosity at 60° Fahrenheit.	VI Flash Point °F.	VII Burning Point °F.	VIII Distillation Results - °F. 0-300 % by Wt.	0-300 Sp. Gr.	300-400 % by Wt.	300-400 Sp. Gr.	400-500 % by Wt.	400-500 Sp. Gr.	500-600 % by Wt.	500-600 Sp. Gr.	600-700 % by Wt.	600-700 Sp. Gr.	Above 700 % by Wt.	Above 700 Sp. Gr.	Loss % by Wt.	IX Unsaturated Hydrocarbons (Absorbed by Fuming Sulphuric Acid)	X Unsaturated Hydrocarbons (Absorbed by Sulphuric Acid)	XI Bromine Numbers Addition	Substitution	Total	XII B.T.U. per Pound.	XIII B.T.U. per Cent Sulphur.	XIV Cracking Results at 5 Gal. per M. Candle Power Gallon	B.T.U. per Gallon	% by Gas	% by Tar	% by Carbon	Specific Gravity Pound	Specific Gravity Gallon.
A. White Oil.	White	Clear	.859	32.9	—	—	—	—	—	—	—	—	—	149	—	3149	—	66.67	—	0.40	0	0	0	0	0	—	0	6.72	18780	70.6	17.9	11.5	1.177	—
B. Kerosene.	White Blue Fl.	Clear	.801	44.8	—	—	—	Trace	—	20.23	.798	61.37	.809	16.98	.832	1.11	—	Above 630 0.31	Heavy Oil	—	5	8	—	—	—	—	—	6.62	19430	71.8	23.9	5.3	.898	—
C. Dirty Transformer	Red-dish Black	Semi-Opaque	.866	33.5	3.93	302	348	—	—	—	—	—	—	Trace	—	49.37	.862	48.67 1.45	860 Coke	0.71	25	27	—	—	—	—	0.12	6.56	19490	72.3	20.5	7.2	.911	—
D. Pennsylvania.	Amber	Clear	.8485	35.0	—	—	—	Fractions of Crude Oil from 300 to 700°F used.													16	24	7.48	3.57	20.62	19967	0.11	6.49	19008	73.0	16.5	10.5	.821	83.5
E. Kansas.	Yellow Blue Fl.	Clear	.838	36.4	—	209	235	—	—	0.27	—	1.987	.813	4.440	.833	24.26	.853	70.55	.873	0.71	6	11	1.35	7.7	16.75	—	0.28	6.33	19400	67.3	21.2	11.5	.902	—
F. Dirty Transformer	Black	Opaque	.869	31.5	5.38	352	398	—	—	—	—	—	—	0.30	—	2.880	.892	49.00 1.5	851 Coke	0.40	23	28	10.31	1.88	14.07	19445	0.14	6.04	18800	69.1	19.0	11.9	.836	78.7
G. Texas.	Black	Opaque	.9707	30.8	3.99	204	218	Trace	—	1.32	.905	4.286	.805	22.46	.8285	31.44	.856	31.12	Heavy Oil	1.20	32	43	9.84	3.57	16.74	20031	0.36	6.04	19890	59.0	21.6	19.4	.833	79.8
H. Mexican.	Red-dish Brown	Semi-Opaque	.8547	33.8	—	—	—	Trace	—	1.108	.769	2.055	.8015	13.67	.844	27.48	.8802	30.70	Heavy Oil	0.48	31	36	28.40	0.61	49.61	19600	1.66	5.94	19750	60.6	20.6	4.8	.833	77.0
I. Pennsylvania.	Green-ish Black	Opaque	.8617	32.8	1.39	—	—	0.13	—	1.369	.8027	16.11	.8316	24.93	.8582	30.76	.871	19.32	Heavy Oil	0.67	27	29	12.86	4.92	21.50	19445	0.11	5.91	—	62.0	26.1	11.9	.824	—
J. Mid-Continent	Amber	Blue Fl.	.8606	33.8	1.52	185	229	—	—	0.60	—	5.48	.814	19.64	.8365	44.23	.858	7.67	.876	1.48	14	17	.8	3.38	6.85	—	0.23	5.91	19700	65.0	20.7	6.3	.835	—
K. Mid-Continent	Red-dish Brown	Clear	.8614	32.8	1.15	—	—	Trace	—	1.21	.820	3.765	.824	34.72	.861	19.70	.899	6.16 6.95	.9259 Coke	0.31	20	28	6.25	5.54	18.13	19931	0.25	5.73	19750	59.2	30.3	10.5	.800	70.3
L. Mid-Continent	Brown	Semi-Opaque	.881	28.9	—	—	—	—	—	0.26	—	0.75	—	1.089	.845	5.477	.871	32.32	.904	1.01	15	20	—	—	—	19658	0.25	5.66	19800	62.9	24.9	10.2	.771	74.8
M. Mexican.	Black	Opaque	.8573	33.3	1.31	300	310	0.38	—	2.30	—	4.78	.8148	43.00	.8528	20.22	.8776	19.17	Heavy Oil	1.07	22.5	34	—	—	—	—	1.93	5.54	19000	61.4	32.6	6.0	.778	—
N. Mexican.	Green-ish Brown	Semi-Opaque	.845	36.7	1.38	89	135	0.77	—	7.96	.7402	17.28	.808	37.34	.8467	25.93	.8763	9.26	913	0.57	21	28	7.15	19.31	29.97	—	1.78	5.48	19720	57.6	28.9	14.1	.778	—
O. Mexican.	Green-ish Brown	Semi-Opaque	.847	35.3	—	112	138	Trace	—	4.82	.7685	18.53	.7923	38.18	.8465	28.80	.8746	9.16	922	0.51	20	30	—	—	—	—	1.37	5.46	19700	58.7	30.7	9.6	.773	—
P. Mid-Continent	Amber	Clear	.843	36.0	1.20	221	236	—	—	Trace	—	14.35	.832	38.50	.8484	33.53	.8814	0.79	Heavy Oil	0.82	8	19	9.12	2.77	14.66	—	—	5.37	—	65.7	28.1	6.2	.766	—
Q. California	Black	Opaque	.9369	19.5	36.53	—	—	Trace	—	3.80	.7627	8.00	.832	20.85	.877	23.90	.917	35.50	Heavy Oil	0.95	85	—	—	—	—	19943	0.48	6.32	18539	52.7	33.6	13.8	.882	65.3
R. Mid-Continent	Green-ish Brown	Semi-Opaque	.8598	33.0	1.26	—	—	—	—	5.48	.8086	19.72	.8278	32.09	.863	19.71	.9136	4.28	Heavy Oil	3.81	15	24	—	—	—	—	—	4.91	—	52.2	31.6	16.3	.686	—
S. Mid-Continent	Green-ish Brown	Semi-Opaque	.8667	31.5	—	182	201	—	—	Trace	—	3.92	.8248	33.45	.8583	19.14	.916	9.50	Heavy Oil	9.03	16	29	5.65	9.09	21.83	19462	0.26	4.95	18300	57.4	31.4	11.2	.672	67.8
T. Mid-Continent	Green-ish Brown	Semi-Opaque	.8561	33.5	1.31	198	206	Trace	—	4.38	.7933	8.90	.8222	22.72	.860	8.50	.9084	11.47	Heavy Oil	1.03	18	30	—	—	—	19778	0.25	4.82	19400	57.8	35.0	7.2	.676	66.2
U. Mid-Continent	Green-ish Brown	Clear	.869	31.1	—	200	211	—	—	Trace	—	35.12	.825	37.26	.866	20.75	.916	6.23	Heavy Oil	0.64	16	28	3.76	8.29	20.32	19349	0.17	4.73	19760	57.3	33.7	9.0	.661	70.4
V. Mid-Continent	Green-ish Brown	Semi-Opaque	.888	27.7	1.24	—	—	Trace	—	0.23	—	5.18	.826	20.87	.869	33.35	.918	10.09	Heavy Oil	0.51	16	28	3.3	0.65	20.50	19109	0.32	4.75	18400	55.9	35.3	8.8	.642	70.1
W. Drip Oil	Yellow	Clear	.8762	29.8	—	—	—			33.2 % distilled over below 235°F. 96.8 % distilled over between 235 and 395°F.											—	—	—	—	—	—	—	0.33	19328	18.8	71.0	10.2	—	—
X. Tar.	Black	Opaque	1.074	—	—	—	—	1.7	—	10.3	—	29.0	—	19.0	—	28.0	—	14.0	Hard Pitch	8.0	—	—	—	—	—	—	—	0.27	—	9.5	64.8	25.7	—	—

Note - Colors were observed in standard 4-ounce bottles.



accurately controlled, and measurements made with pyrometer fire ends situated at four points along the tube. Oil is introduced into this cracking tube from the glass burette *E*, at the regulated rate of 5 cubic centimeters per minute. The finished gas is scrubbed with beads and cotton, metered and then passed into the small holders *I*, from which it is sampled and tested after storage for 1 hour. Since both the blue gas and finished gas were metered, the difference between the two at the end of the run furnishes a correct indication of the volume of oil gas made.

Candle-powers were taken using the pentane lamp as the standard, and the No. 7 Bray L. P. slit union burner for testing the gas. Analyses were made with the Morehead burette, palladium black being used to absorb the hydrogen. The specific gravity was taken with Schilling's apparatus. Heating values were obtained with the Junker's gas calorimeter.

Experience has shown it to be possible to obtain results in the laboratory which do not vary more than 5 per cent. from the values obtained at the works. Furthermore, duplicate tests on the same oil always agreed within less than 1 per cent. when the proper precautions were taken. In view of these facts considerable reliance may be placed on the cracking data, as furnishing a correct means of valuating gas oils. However, as it would be impossible for many laboratories to employ such a device for testing oils, a study has been made of the more common and simple tests usually applied to them, with the end in view of furnishing an intelligent basis of interpretation. The following are some of the conclusions reached.

Color

The color of an oil offers but little indication as to its real characteristics. Western oils, from California, Texas and Mexico are usually black in color. Eastern crudes possess a lighter color. The process of refining produces great changes in appearance and the fractions may be entirely different from the original oil. Clear oils have usually been refined considerably. Light colored oils, as a rule, are fairly good for gas making purposes. They apparently have not been cracked to such a great extent as some of the darker oils. On the other hand some oils of a light color have been encountered which contained considerable portions of low boiling fractions of an inferior nature which decrease their value.

Odor

Besides observing the color of an oil sample, the chemist usually notes the odor. This may be sweet, mild, pungent or offensive. The latter odors indicate a high amount of sulphur. Most gas oils, however, have a somewhat disagreeable smell and the odor furnishes no more real indication of value than color. Gas oils that have been cracked during the process of refining usually possess a slight aromatic odor which can be detected by an experienced observer.

Specific Gravity

Formerly specific gravity was the only criterion by which an oil was judged. It is now generally known that this characteristic can not be depended upon to furnish the required knowledge. The specific gravity is a useful figure as an aid in calculation of various works results, and as a quick test to determine the character of oil shipments.

When an oil is distilled under vacuum and the various fractions gasified, the high boiling or heavier gravity portions will usually yield the best results. In general, for a given boiling point, the lower the gravity the better will be the quality of the oil. Gravity results are listed in Table I, Column 3, and their relation to the sperm value of the oil is shown in Chart II. It will be readily seen that no definite relation exists.

However, in testing several oils of different specific gravity which were obtaind from the same crude stock, it was noticed that the higher gravity or lower Baume degree oils were of slightly better quality. This is no doubt due to the fact that a gallon of oil contains a greater weight of valuable constituents.

Refractive Index

The refractive index has been considered by some as an aid in discriminating between oils. In his researches connected with the production of gasoline, Rittman has investigated the physical characteristics of numerous oils. His conclusion concerning the refractive index is that it varies proportionately with the gravity and offers no additional information to that which the gravity test supplies.

(Continued on page 322)

AMERICAN
GAS LIGHT JOURNAL

FIFTY-EIGHTH YEAR.

Published Weekly by
AMERICAN GAS LIGHT JOURNAL, INC.
42 Pine Street, New York, N. Y.

ELBERT P. CALLENDER, President
STANTON G. KRAKE, Vice-President.
FREDERICK A. SOUTHWORTH, Secy.-Treas.

EUGENE C. MILES, Editor

Subscription, $3.00 per year, including postage in the United States, Mexico, Cuba, Porto Rico, Hawaii or the Philippines.
In Canada, $4.00. Foreign, $5.00.

Entered at the Post Office, New York City, as Second Class Matter.

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The Convention at Atlantic City—Its Significance to the Industry

To-day at Atlantic City, the National Commercial Gas Association starts forth on another year of its extremely useful efforts in behalf of the gas industry. To these men—more than the sellers of our industry—the AMERICAN GAS LIGHT JOURNAL extends its heartiest felicitations. Though their greatest work as an association still lies ahead of them, their past achievements have been truly remarkable. Their association has more than fulfilled the expectations of its founders, and has become an essential adjunct of the gas industry.

Each year more and more is expected of the National Commercial Gas Association. Each year it has fulfilled these expectations, and there is little reason to doubt that the results of the ensuing year will be different in this respect than those which have preceded it. These men have accomplished what they have because they had faith in the industry, because they believed in the ability of its personnel and because they put their whole heart and soul into the task that was and still is ahead of them.

They have been more than sellers of gas. They have discovered new uses for gas and have ardently pressed the gas man to adopt his appliances to the extent that he might obtain some share of the vast business to which the various merits of gas entitle it to. It required the stoutest of hearts to enter into the task which was the basic reason for the association's formation, but the need of such courage in the face of what might have seemed hopeless odds, is to a large extent, past. The gas industry has reached the point where it believes in the National Commercial Gas Association, is sympathetic with its purposes and has confidence in its membership. No longer does the association need to justify its existence. The work now ahead is solely constructive work, and work in which the results attained will be more truly proportionate to the efforts expended.

Sales of Gas for Illuminating Purposes

Many gas men who are inclined that way, undoubtedly will be cast into the deepest despondency, and the general run of electrical men will be correspondingly elated by the information furnished by the U. S. Geological Survey—published elsewhere in this issue—which seemingly shows a marked decrease, not only in proportion, but in actual volume, of gas sold for illuminating purposes in 1915. But these figures should be considered with judgment. In the opinion of this journal, they emphasize the need of devising some consistent means of alloting the proportions of gas to its various uses rather than any especially alarming advance notice of the speedy closing of possibly our best individual market. The Government, in fact, in its statement calls attention to the unsatisfactory conditions that exist in regard to determining what proportions of the whole gas output should be allotted to the various uses.

We should not, however, let this argument weigh too heavily with us. Electric lighting unquestionably has made serious inroads in our lighting business, and in many cases it is right that it should have. In these particular cases its merits entitle it to the place; but, on the other hand, for many lighting purposes, gas is not only preferable from the point of economy, but would be preferable at any price. We must select and segregate these various uses. It is foolhardy to waste our energies combating for fields to which our merits do not entitle us. We must conserve them rather for a more energetic fight for markets which are honestly ours by rights. There is need for a more intelligent selection of the kinds of lighting business we should go after. There is need, above all, for a shedding of a great deal of our complacency. We must rouse ourselves and fight for our business. We are winning many new markets. The gas output in the aggregate is increasing by strides. Yet, because of this, we must not be content to surrender markets we already possess, figuring on the new kinds of business we are gaining to keep the balance even.

We are not an industry at a stand still. We are a progressive industry. After a hundred years of service we have not even gotten a good start. Our slogan must be to hold what we already have and fight for more. That we can do this, and easily, is beyond question. All that is needed is the requisite energy and tireless thinking.

The Value of the Heating Load

In many cities the gas companies are making especially strong efforts to increase the number of their gas-heating installations. Almost daily we hear of cases where these efforts are meeting with a remarkable degree of success. But always the attainment is marked by the number of installations. Seldom do we find it expressed in terms of increased gas output.

Now comes the report from Louisville, Ky., that in a certain week the gas output shows an increase of 60.7 per cent over that for the corresponding week of last year. The increase is attributed to the large number of gas heating installations made during the past summer.

Such a report deserves a more prominent mention than it would ordinarily get, contained as it would be in a brief note in the news pages. This is speaking in terms that will make the gas man open his eyes. Large appliance sales arouse his interest it is true, but not to the extent that increased output of gas does; for, after all, he is a gas man, and his primary purpose is to make and sell that commodity. He realizes, of course, that additional gas-burning appliances mean increased consumption of gas, but the fact does not strike home so forcibly as when the result of any campaign is expressed concisely in terms of increased gas consumption in preference to its expression in terms of appliances sold.

This journal, like every other organ of the industry which has its welfare and advancement at heart, has been unsparing in its effort to arouse within the gas man in general a full appreciation of the possibilities that lie in the industrial fuel field.

It has made no especial effort, however, to accomplish this by its editorials.

Editorial comment has been merely incidental. The advancement of theories and expression of opinion has, no doubt, a considerable influence in stimulating activity along certain lines, but nowhere near the influence that a frank, concise statement of what has been accomplished in terms that appeal directly to the one whom it is seeking to influence has.

For this reason this journal has confined its main efforts in its advocacy of the development of the industrial fuel business to seeking out instances where gas was so applied and where figures were at hand to show what the installations meant in terms of cubic feet of gas used.

A few statements to the effect that this or that company is selling one hundred million cubic feet of gas per year for industrial purposes will do more, in the opinion of the American Gas Light Journal, to arouse the interests of the gas man in such possibilities than will all the glowing words of theoretical promise that could be uttered by fifty speakers and published by all the journals in the gas field in the course of a month.

Let us therefore get down to figures in demonstrating the advantages of this or that field of gas consumption to the gas man. And let us also express such figures in terms that will appeal directly to him. A report of a thousand appliances of a particular kind, sold in a relatively short time, doubtless will make the manufacturer's eyes glow, but the gas man is interested principally in the sale of gas.

Optimism

"Look, therefore, whether the light that is in thee be not darkness." In other words, be sure that the knowledge you have of the gas business is not used to find and talk about the dark side rather than the bright side. No business and no industry can reach its maximum development unless it is led by optimistic men. The gas business is certainly blessed by some very optimistic men, men who radiate sunshine and encouragement. Why should not every gas man be like these men?

It has been estimated that every all-gas kitchen saves at least a half hour each day of the time of the person who must do the work in it. This means that for every 16 all-gas kitchens a gas company has installed on its mains at least eight hours a day of hard labor are saved. This surely is something to feel optimistic about. It is releasing the time of many housewives for work that is more constructive and more beneficial to the community than the drudgery of cleaning up ashes, urging along a smoking fire, and suffering in a hot kitchen.

It has been demonstrated that the cooking accomplished in the average kitchen with a half a ton of coal can be done with two thousand cu. ft. of gas or less. Placing the heat value of the coal at 12,000 B. t. u. per pound and that of the gas at 600 B. t. u. per cubic foot we find that 1,200,000 heat units in gas do the work that 12,000,000 heat units in coal will do. In other words gas is ten times more efficient than coal. This, however, is not all. When coal is burned in the kitchen a great many very valuable by-products are destroyed past recovery. In the gas works these are all recovered and used in the manner most productive to the good of mankind. The gas business, therefore, will not only make the coal resources of the country last many times longer than they otherwise would, but it also recovers for the use of mankind many products that would be irreparably lost if the coal was used in any other way. This good work certainly is worthy of the pride with which the gas man looks upon it. Such a genuine service will ultimately win the support of all mankind. The outlook could hardly be more bright.

In the same way we can analyze the gas business from beginning to end and discover reasons for rejoicing and looking forward with hope rather than bemoaning. Even the very keen competition that so many are promising the gas industry can be looked to as more beneficial than harmful to the industry. History as well as modern experience shows that business has been benefited to a far greater extent than it has been harmed by healthy honest competition.

There does not appear to be anything in the industry to be pessimistic about except the few individuals who still persist in talking hard times.

Conserving Consumers

There is probably no greater mistake any business man can make than the seeking out of new customers at the expense of the attention that should be paid to the customers already secured. This applies to every business, but with especially great force to the gas business.

For each consumer the gas company must invest a certain sum of money in service pipes, meters, etc. If this consumer does not exceed a certain consumption per month the gas company actually loses money, its investment and service. It, therefore, will pay the company a great deal better to increase the consumption of this consumer than it will to secure another and make the additional investment required to serve him only to discover that he consumes no more gas than the first. Instead of bettering matters they have been made worst.

There is probably not a single gas company in the country that can state that it is selling all the gas it is possible to sell to each individual consumer. In other words there is still a big field for increasing gas consumption right among the present consumers. It is also in this field that the greatest profit is to be derived.

Usually all that is necessary to increase the consumption of a consumer is first to show him how to secure the very best results from the gas he now uses, and, second, how it will be economical to use gas for purposes for which he never has used it. It must always be borne in mind that the customer must be benefited first if he is to eventually use more gas. It cannot be left to him to support the gas company. It is the duty of the gas company to show the consumer how the company can benefit him.

The conservation of present consumers, therefore, simmers down to the question of educating them. If each consumer knew as much about the advantages of using gas as every gas man ought to know them there would be no cases of the gas company carrying consumers at a loss.

Because the results are not always so tangible as they might be the gas man is in danger of thinking that the work done with the present consumers is not as profitable as that done in securing new ones. It is easier to count meters than to reckon the percentage of increased consumption among the consumers who have been educated. For this reason we do not find that every company sends a demonstrator to each consumer from two to four times a year, conducts a cooking school and frequently inspects all industrial and commercial appliances to make sure that they are giving the very best results.

That work of this nature pays is being proved not only in the gas business, but also in many other lines of business. A great many automobile companies advertise their service to car owners as much as they do their car. If inspection service pays these concerns who can benefit from it in only a very indirect way it surely should greatly benefit all gas companies.

(Continued from Page 319)

Surface Tension

Surface tension of various oils was also investigated by the Government and was found to be affected to a great extent by small amounts of impurities in the oil, so that the results of this test can not be relied upon. Surface tension may prove of use in the examination of asphalts and petroleum residues, which are intended for road building purposes. There does not seem to be much logical relation between this test and the gas making value of an oil.

Viscosity

Viscosity tests are of course of prime importance in the valuation of lubricating oils. When applied to gas oils, this test is only useful in indicating the ease with which they may be handled in the pumps. A high viscosity gas oil will frequently cause trouble in cold weather when unloading cars and necessitate the use of steam coils. Column V of Table I contains the results of a few tests made on the viscosities of various oils, and it will be seen at a glance that no relation exists between viscosity and the actual efficiency of cracking. The determinations given were made on the Scotts Viscosimeter. A viscosity greater than 4 at 60 deg. Fahr. indicates that difficulty will be encountered in transporting the oil through exposed pipes in cold weather.

The cold test is also useful in determining whether the oil will flow in cold weather and should be made on oils which contain a large percentage of higher boiling paraffine waxes or asphalt.

Flash and Burning Points

Table I also contains the various flash and burning points of oils, as shown in Column VI. These determinations were made with the open tester. No uniformity exists between the flash point and enriching value. The flash and burning point determination is necessary from the standpoint of safety. An oil which flashes below 170 deg. Fahr. is frequently regarded as unsafe, although oils with much lower values have been successfully stored by gas companies. The efficiency of oil refiners in extracting gasoline usually results in present day gas oils possessing safe flash and burning points.

Heating Values

The heat value or B. t. u. per pound of gas oil has been advocated by some authorities as a possible means of ascertaining its value. The committee of the Dutch Gas Managers Association on the testing of gas oils reported in 1912 that the quality of an oil is probably proportional to the heating value. They were not able to determine at that time whether the B. t. u. test was sufficiently accurate to discriminate between the quality of oils of similar type.

On the other hand Sherman and Kropp report that the heating value of an oil varies with the gravity. They state that the formula

$$\text{B. t. u. per pound} = 18{,}650 + 40\ (\text{Be}^\circ - 10)$$

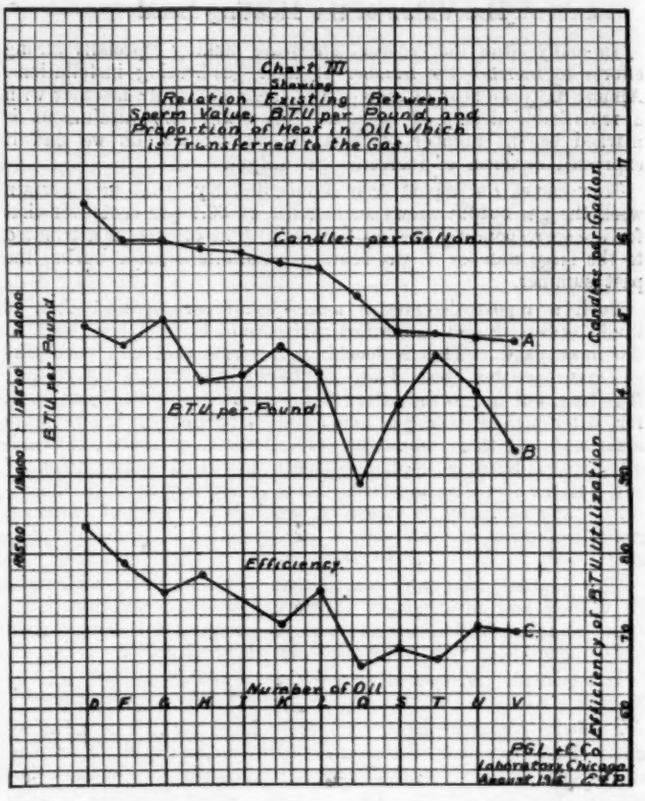
gave results within 1 per cent. of actual or determined value on more than 60 oils tested. This being true it is evident that the B. t. u. test can not be relied upon to furnish an idea of the enriching value, since the gravity itself is no indication.

Tests made in The Peoples Gas Light & Coke Company's Laboratory on about a dozen oils, are listed in Table I and Column XII. The Mahler bomb calorimeter was used. These tests also show a similar relation between the specific gravity and heating value to that found by Sherman and Kropp. For the sake of convenience, these results have been transferred in curve form to Chart III, where comparisons are made with the sperm value. It will be noted that high B. t. u. oils gave good candle per gallon values when gasified. However, some relatively low B. t. u. oils also furnished good results. It is again apparent from this data that no definite relationship appears to exist between the B. t. u. and the enriching value of oils.

This failure of the B. t. u. results to indicate the gas making quality of an oil is no doubt caused by the different rate of decomposition of oils when exposed to heat. Some oils will decompose rapidly to carbon and it is evident that more heat units are lost to the gas in this case. From the curves *C* on Chart III, it will be noted that the efficiency of utilizing the B. t. u. in the oil varies from 85 to 65 per cent. The nature of the chemical combination of the constituents of the oil, which possess no particular relation to the heating value, is doubtless the cause of this variation in efficiency.

Fractional Distillation

Next to specific gravity fractional distillations have been relied



on in the past to indicate the value of gas oils. For use as an aid in gas manufacture it is convenient and sufficiently accurate to collect fractions of an oil which have distilled over each 100 deg. Fahr., up to 700 deg. Fahr., or if necessary until no more distils off. Generally speaking, the fractions become more valuable as the temperature at which they distil over becomes higher. This is especially true when the fractions increase in volume up to 700 deg. Fahr. With some oils, when the maximum distillate comes over at some intermediate temperature between 400 deg. to 600 deg. Fahr., and then rapidly decreases, the higher boiling fractions have been found to be inferior.

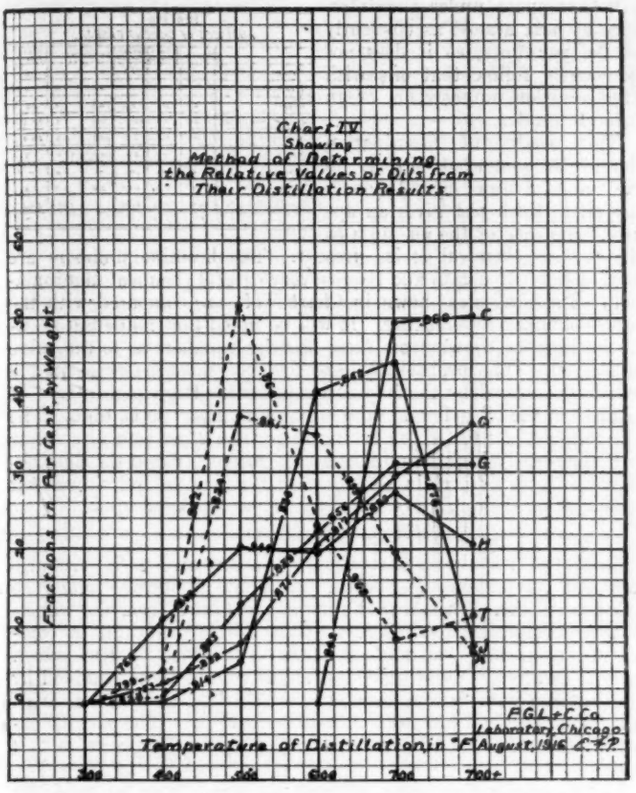
Again the specific gravity of the distillation fractions are important in determining their relative values. For a given boiling point the value increases with a corresponding decrease in the specific gravity of the fraction. The reason for this is evident when comparisons are made between specific gravities of compounds of the different chemical series having the same boiling point. In Chart V, the boiling point and specific gravities of some compounds which occur in petroleums are listed. It will be noted that paraffine compounds are the lightest and are followed respectively by the olefines, naphthenes and aromatic compounds. It is now an established fact from a gas-making standpoint that paraffine oils rank first as to their enriching value, olefines are slightly inferior and are followed by naphthenes. Aromatics are decidedly inferior.

The above principle may easily be applied in interpreting distillation results. As an illustration, the curves of several oils are shown on Chart IV. Oil *C* is a highboiling point transformer oil. This oil gave very good results in cracking. The comparatively low gravities of these high boiling portions should be noted.

Oil *G* is from the Texas field, *H* is a Mexican oil and *O* is from California. These oils show very similar results when distilled, and the distillation curves are of a distinctly different form from those of the other gas oils. The gas-making value of these oils vary according to the alphabetical order in which they have been arranged. For any given fraction, the gravities of curve *G* are lower, those of *H* are intermediate, while those of the California oil *Q* are much heavier.

Oils *J* and *K* are both from the mid-continent field. The larger percentage and lighter gravities of higher boiling fractions of *J* would indicate it to be the better of the two. The candles per gallon values obtained in cracking were 5.91 and 5.73 respectively.

Oil *T* is also a mid-continent oil. The large portion distilling



over between 400 deg. and 500 deg. Fahr. appears to be an indication of inferiority since this gave only 4.82 candles per gallon, when cracked. When kerosene is added to gas oils the effect would be to increase the fraction boiling from 400 deg. to 500 deg. Fahr. Kerosene itself yields excellent results when cracked. A sample of commercial kerosene gave 6.62 candles per gallon. From the principles stated concerning the value of oils with low boiling points and high gravities one might expect lower results with this oil. Kerosene, however, consists almost wholly of saturated or paraffine compounds, while the lower boiling fractions of some gas oils contain a large percentage of unsaturated compounds. This fact may account for the apparent inconsistency noted.

A good gas oil should show less than 2 per cent. of coke, when the distillation is carried far enough to obtain carbon residues. Furthermore, if the fractions vary widely and the oil is composed of large portions of low boiling compounds, with a correspondingly large amount of high boiling compounds, it is not to be expected that as good results will be obtained as in the case where the bulk of the oil has substantially the same boiling points within a small temperature range. The heavy or high boiling compounds are more complex and are more easily decomposed. In general they crack more efficiently at lower temperatures, while the simpler or less complex light oils decompose more efficiently at slightly higher temperatures.

Ultimate Analysis

As yet but little study has been made as to the value of an ultimate analysis in rating gas oils. That there is a possibility of this determination becoming useful is evident from a consideration of their chemical composition. Gas oils consist chiefly of the six series.

Paraffine	C_nH_{2n+2}
Polymethylene or naphthene	C_nH_{2n}
Olefine	C_nH_{2n}
Acetylene	C_nH_{2n-2}
Asphaltic	C_nH_{2n-4}
Aromatic	C_nH_{2n-6}

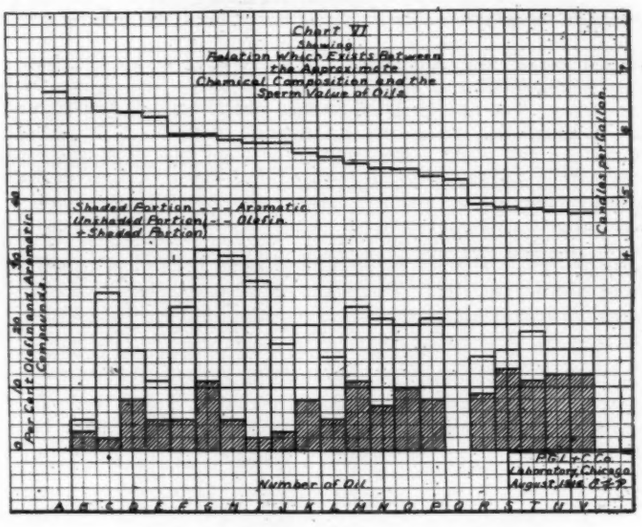
It has already been stated that the paraffine compounds are superior to the others. They are also more fully hydrogenated and are therefore more capable of decomposing with the formation of larger amounts of methane and illuminants. It would seem that the higher the hydrogen content of an oil the better the cracking results obtained. The ultimate analysis is rather difficult to perform and will never find favor as a quick test. No study has been made of ultimate analysis in connection with the other tests of this paper, so we are in no position to pass on the real merits of this kind of analysis. From what other investigators have done, however, and from actual analysis of different types of oils found in this country, it appears that the considerations based on ultimate analysis do not apply. The analyses of some principal type oils have been listed by J. L. E. Cheetham. The data given in regard to hydrogen content furnishes no consistent and definite means of discrimination.

Sulphur

Sulphur determinations on an oil are easily and quickly made when an oxygen bomb calorimeter is available. This determination is very useful in that it provides information as to the burden the purifying boxes will be obliged to carry. From a number of oils tested it has been observed that about 40 per cent of the sulphur in the oil appears in the gas as hydrogen sulphide, the remainder combining with the tar. Although oils with as high as 2 per cent sulphur are used in some plants, the usual content should be less than 0.3 per cent.

It appears probable that sulphur in the oil contributes to a greater formation of tar. To clear up this point, a gas oil was mixed with 10 per cent of carbon bisulphide and cracked in the usual manner. No appreciable difference in the amount of tar formed was noticed, while the hydrogen sulphide produced was extremely high. It is possible that sulphur dissolved in the oil, instead of carbon bisulphide, might give different results, but this has not been tried as yet.

As the temperature of cracking increases, more of the sulphur appears in various forms in the tar, and less hydrogen sulphide is found in the gas. This may be due to the fact that greater gas and less tar volumes are formed at high temperatures.



Sulphonation

As a result of considerable research on oils Ross and Leather conclude that:

(1) Open chain hydrocarbons have the best value for gas making.

(2) The presence of double bonds in the chain slightly reduces the value.

(3) The presence of one or more rings considerably reduces the value.

It is therefore evident that a method which determines the portion of paraffine, unsaturated and aromatic compounds, should be of value in rating oils. When an oil is mixed with sulphuric acid the olefine and acetylene compounds are attacked and sulphonic acids formed. Fuming sulphuric acid acts upon the aromatic compounds and if of the proper strength will not attack the paraffines. This principle was applied with the hope of obtaining a quick and valuable test. The sulphonations were made in Babcock milk testing bottles. A modification of the U. S. Forest Products Laboratory method for sulphonation of creosote oils was employed. Only 2 cubic centimeters of the oil were used. This was necessary because of the high amount of paraffines present in gas oils. A 37/N solution of sulphuric acid was used to obtain the aromatic and

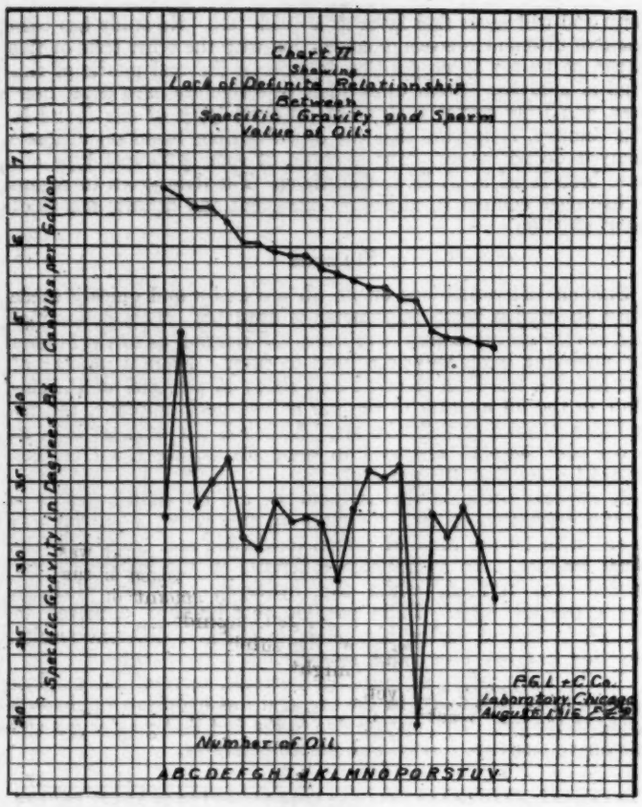


Chart VI
Showing
Lack of Definite Relationship
Between
Specific Gravity and Sperm
Value of Oils
Specific Gravity in Degrees Bé
Candles per Gallon
P.G.L.+C.Co.
Laboratory Chicago
August 8th 1916
Number of Oil
A B C D E F G H I J K L M N O P Q R S T U V

olefine compounds. Another sample was treated with concentrated sulphuric acid of 1.84 specific gravity, to obtain the olefines and acetylenes. The results of the tests appear to be somewhat irregular, although they yield some information of value. The amount of olefines and unsaturated compounds found with sulphuric acid was not an indication of the real value. Many of the oils had already been refined with sulphuric acid, especially the clear or light colored ones, and gave low sulphuric acid absorptions. Some of the inferior oils showed a higher proportion of aromatic compounds. These oils are known to be heavily cracked, the product from a pressure still. Texas and Mexican oils also contained large portions of unsaturated and aromatics, but yield good cracking results. By comparing the results of sulphonation with the distillation analysis, it is possible that quite definite conclusions can be drawn concerning the relative values of the oils. Chart VI shows the relation between the proportion of the various compounds and the enriching value. The larger percentage of aromatic compounds in the inferior oils is to be noted.

Bromination

Another well-known method of differentiating oils is by bromination. Bromine acts upon unsaturated compounds forming addition products. It also acts upon the aromatic constituents forming substitution products and hydrobromic acid. In the dark, or diffused light, paraffines and naphthenes are not attacked. The method of conducting the test is fully discussed by Park and Worthing in the Institute Proceedings. The authors have not demonstrated the value of this method, however, since they did not make direct comparisons between the bromine numbers and the actual sperm value of the oils tested. Column XI of Table I contains the bromine numbers of some of the oils tested. These results are also shown graphically in Chart VII.

The general rules to be applied in determining the value of oils from bromination results are as follows.

(1) Oils with low total bromination numbers should be the best, because such a low number indicates a high percentage of paraffines.

(2) Large substitution numbers denote the presence of aromatic compounds and oils with large substitution numbers are usually of inferior quality for gas making.

(3) The addition number indicates the percentage of unsaturated compounds present. Some of the olefine and other unsaturated oils will decompose under the influence of heat almost as efficiently as the paraffines, so it does not necessarily follow that oils with high addition numbers are of an inferior grade.

TABLE II
ANALYSES OF DILUENT GASES

	Nitrogen	Carbon Dioxide	Carbon Monoxide	Hydrogen	Methane	Olefines
Carbon Dioxide	4.5	84.9	1.9	0.1	0.3	4.4
Illuminants	—	—	—	0.3	1.2	6.0
Oxygen	0.7	0.5	0.5	0.9	0.4	0.2
Carbon Monoxide	0.5	0.5	84.9	0.5	1.6	38.6
Hydrogen	0.5	0.3	2.0	91.2	8.3	20.4
Methane	—	—	2.3	4.6	83.6	1.7
Ethane	—	—	—	—	2.6	—
Nitrogen	97.8	3.1	0.2	2.4	2.0	2.9
Specific Gravity	.9699	1.4969	.9699	.1113	.4284	.8415

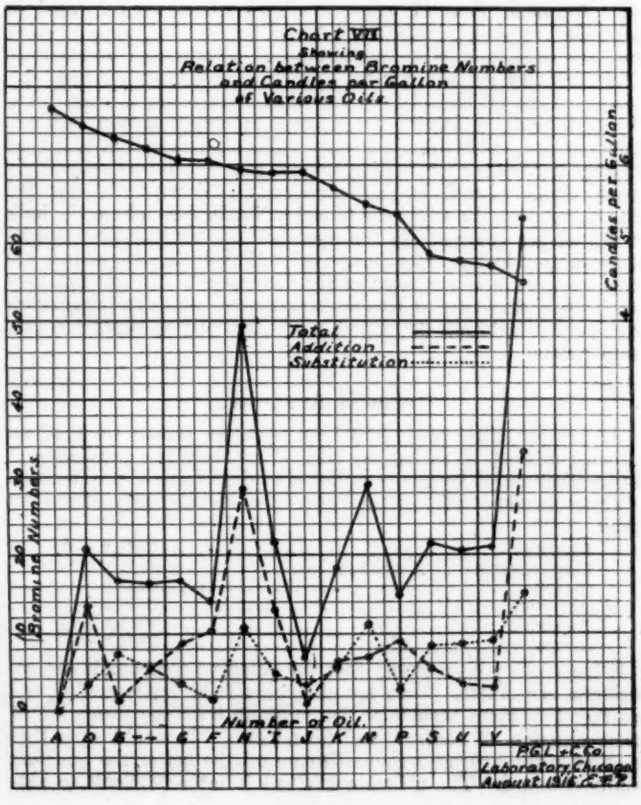
The results of bromination should be somewhat similar to the values obtained by sulphonating oils. Each test gives an approximate idea of the amounts of the various chemical series present. The bromine numbers are more difficult to obtain and require very careful chemical manipulation. The results as shown in Chart VII are compared with the values obtained by cracking. It will be noted that no definite conclusions can be drawn from these bromine numbers as to the value of the oils. The probabilities are that the inconsistencies in the results are caused by the impurities present. High percentages of sulphur in the oil will cause the bromine numbers to be high. The two Mexican oils tested containing more than 2 per cent of sulphur give abnormally high bromination absorptions. From the data obtained it appears certain that bromination, as an individual test to determine the quality of oils, can not be depended upon.

Formolite Number

Nastjukoff has shown that when oils are treated with sulphuric acid and formaldehyde, a brown precipitate is formed which he called formolite. The formolite number obtained from the weight of this precipitate is a measure of the cyclic unsaturatetd compounds in an oil. The method has been modified by Richardson and the results he found differ but slightly from those obtained by sulphonation with fuming sulphuric acid. This method was tried but found very tedious and difficult to operate. The results obtained were not promising enough to justify further work on this line.

The foregoing discussion of methods which may be used for evaluation gas oils has demonstrated the difficulties which will be encountered in arriving at correct conclusions. Much experience and good judgment are required to properly place an oil. The cracking test is the most definite in its results. Furthermore, such a test can easily be conducted in 6 hours and is well worth the time spent on it, because of the additional information which can be procured concerning the proper temperature of carbureting.

The investigation of the effect of various gaseous atmospheres upon the results of cracking, was undertaken with the object of



determining the influence of each constituent of the blue gas upon the quality and quantity of the end products produced. In order to make comparisons special care was taken to maintain the time of contact approximately the same with each gas used.

The atmospheres used were as follows: nitrogen, carbon dioxide, carbon monoxide, hydrogen, methane, blue gas and a mixture of blue gas with 10 and 20 per cent of steam respectively.

Preparation of Gases

Nitrogen was obtained by burning phosphorus in a large bell jar over water. When the combustion was complete the residual nitrogen was transferred to the holder and the process repeated until sufficient gas was obtained. Only 5 ft. of gas was required for the tests, otherwise the cuprous oxide method for preparing nitrogen would have been adopted.

Carbon dioxide was produced by the action of hydrochloric acid on marble chips in a Kipp generator, the gas being washed with water to remove the acid fumes.

Carbon monoxide was made by passing a slow stream of oxygen through a bed of incandescent coke. The same furnace used for the manufacture of blue gas was utilized for this purpose.

The Kipp generator was used in preparing the hydrogen. Hydrochloric acid acting upon granulated zinc produced the desired gas. Scrubbing through a wash bottle containing water removed the acid fumes.

Methane was formed by heating a mixture of two parts of sodium acetate with one part of sodium hydroxide in an iron retort. This gas contained some illuminants, which necessitated washing through sulphuric acid.

The blue gas used in these tests was prepared by passing steam through a bed of incandescent coke at a rate sufficient to insure good decomposition. The furnace is shown in Chart I.

The proper proportion of steam was introduced with the blue gas by means of a flash boiler. This consisted of a 2-inch short nipple capped at both ends. The upper cap contained an inlet, through which water was introduced from a burette, and an outlet leading

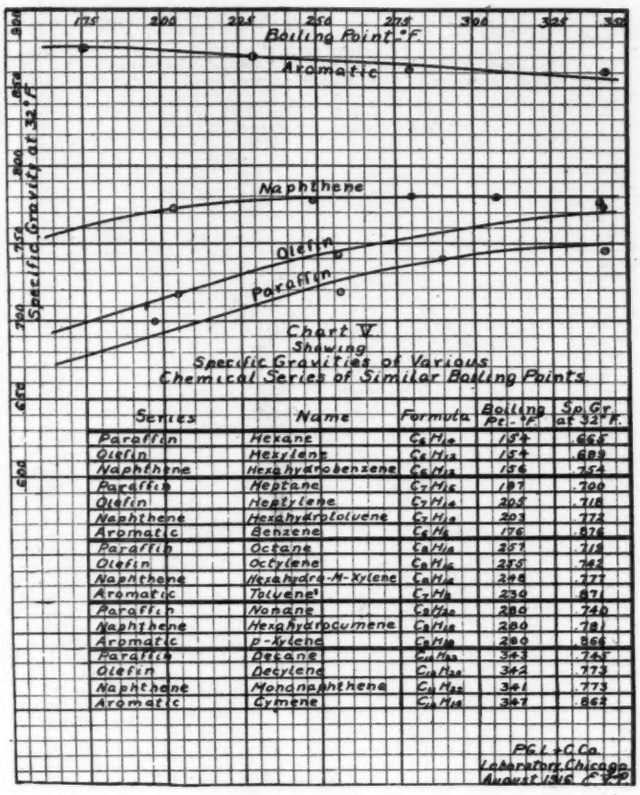


Chart V
Shewing
Specific Gravities of Various
Chemical Series of Similar Boiling Points.

Series	Name	Formula	Boiling Pt.-°F	Sp. Gr. at 32° F.
Paraffin	Hexane	C_6H_{14}	154	.665
Olefin	Hexylene	C_6H_{12}	154	.689
Naphthene	Hexahydrobenzene	C_6H_{12}	156	.752
Paraffin	Heptane	C_7H_{16}	197	.700
Olefin	Heptylene	C_7H_{14}	205	.718
Naphthene	Hexahydrotoluene	C_7H_{14}	203	.772
Aromatic	Benzene	C_6H_6	176	.876
Paraffin	Octane	C_8H_{18}	257	.718
Olefin	Octylene	C_8H_{16}	255	.742
Naphthene	Hexahydro-M-Xylene	C_8H_{16}	248	.777
Aromatic	Toluene	C_7H_8	230	.871
Paraffin	Nonane	C_9H_{20}	280	.740
Naphthene	Hexahydrocumene	C_9H_{18}	280	.781
Aromatic	p-Xylene	C_8H_{10}	280	.866
Paraffin	Decane	$C_{10}H_{22}$	343	.745
Olefin	Decylene	$C_{10}H_{20}$	342	.773
Naphthene	Mononaphthene	$C_{10}H_{20}$	341	.773
Aromatic	Cymene	$C_{10}H_{14}$	347	.862

P.G.L. + C. Co.
Laboratory, Chicago.
August, 1916. C.F.P.

RESULTS ON CRACKING GAS OIL IN ATMOSPHERES OF VARIOUS GASES.

TABLE III.

Kind of Diluent.	Nitrogen		Oil Only		Carbon Dioxide		Carbon Monoxide		Hydrogen			Methane		Blue Gas					10% Steam				20% Steam			
Temperature - °F	1304	1349	1315	1349	1300	1350	1305	1358	1302	1355	1416	1300	1349	1212	1256	1315	1357	1452	1250	1300	1350	1400	1300	1350	1400	1450
Cu. Ft. Oil Gas per Gal. Oil	58.5	61.2	62.6	66.2	66.0	66.2	57.8	63.7	50.2	53.6	55.8	57.2	61.9	32.6	45.9	53.2	56.6	59.8	54.2	56.6	60.4	65.2	53.2	61.8	61.7	66.8
Cu. Ft. Total Gas.	203.4	205.5	62.6	66.2	203.2	201.8	204.0	207.0	197.8	200.0	200.0	196.2	201.0	176.0	183.0	195.2	198.0	201.8	206.0	205.8	208.0	216.5	198.5	200.7	200.2	206.0
Gallons per M.	4.92	4.86	15.97	15.11	4.92	4.96	4.90	4.82	5.05	5.00	5.00	5.09	4.97	5.67	5.28	5.12	5.05	4.96	4.87	4.86	4.80	4.62	5.04	4.96	4.98	4.85
Candles per Gallon	—	—	—	—	—	—	4.33	3.90	4.77	5.00	4.85	5.74	5.97	3.90	5.14	5.73	5.48	4.72	5.54	5.62	5.44	5.26	5.14	5.28	5.04	4.73
Per Cent Oil Gas	28.8	29.8	100	100	32.44	32.82	28.35	30.75	25.50	26.75	27.95	29.45	30.80	18.48	24.28	27.23	28.50	30.2	26.35	27.50	29.0	30.0	29.86	30.7	30.9	32.4
Candle Power	—	—	—	—	—	—	21.20	18.72	24.10	25.00	24.26	29.22	29.66	19.75	27.12	29.29	27.75	23.39	27.00	27.31	26.12	24.32	25.85	26.22	26.17	23.00
B.T.U.	446	479	1276	1208	489	484	565	682	728	749	752	712	725	633	718	734	728	721	716	720	715	695	750	755	736	714
B.T.U. per Gallon	90700	98500	79900	78000	99400	97500	91600	96100	93000	99200	99900	88000	96000	67750	92100	99300	100750	103300	98700	100700	101600	102000	107200	98700	105500	105500
Per Cent Tar.	38.0	34.8	43.6	38.0	37.5	29.4	41.2	38.1	30.4	27.5	27.1	33.9	32.5	48.8	37.6	31.8	30.3	26.0	29.5	24.2	23.9	24.3	20.6	25.6	21.2	20.2
Per Cent Carbon	12.7	16.2	12.4	15.8	20.2	24.3	5.2	8.7	7.1	6.7	8.7	14.2	11.9	12.8	9.5	11.4	10.5	17.1	11.2	15.2	18.1	18.3	5.9	5.4	14.8	14.8
Per Cent Gas.	49.3	49.0	43.8	46.2	42.3	46.3	53.6	53.2	62.5	65.8	64.2	51.9	55.6	38.4	52.9	56.8	59.2	56.9	59.3	60.6	58.0	57.4	73.5	69.0	64.0	65.0
Hydrogen Sulphide.	10	13	—	—	—	—	10	11	10	8	12	—	—	111	105	100	96	85	—	—	—	—	88	87	88	89
Specific Gravity.	.9110	.9005	.6853	.6555	1.147	1.153	.8910	.8780	.3778	.3944	.3810	.6188	.6210	.6333	.6658	.6760	.6880	.6506	.6749	.6625	.643	.633	.6756	.6474	.6482	.6556
Carbon Dioxide.	0.4	0.3	0.9	1.2	62.5	64.2	1.3	1.4	0.4	0.4	0.5	0.5	0.4	4.4	4.0	3.4	3.6	3.4	2.2	1.8	2.2	1.8	3.2	3.2	3.4	3.4
Illuminants	12.6	14.1	31.0	27.4	13.9	13.5	14.7	14.4	12.5	13.2	12.8	14.6	15.2	11.0	14.6	15.4	15.0	13.6	13.6	13.6	13.0	12.2	14.2	14.7	13.7	12.8
Oxygen.	0.3	0.2	0.6	0.6	0.6	0.5	0.3	0.4	0.7	0.4	0.2	0.6	0.6	0.4	0.4	0.3	0.4	0.4	0.4	0.6	0.6	0.4	0.6	0.7	0.8	0.8
Carbon Monoxide.	1.7	1.2	2.0	1.6	1.8	1.6	58.0	58.0	2.0	1.0	1.6	2.8	2.0	31.8	28.8	28.0	27.2	26.6	32.4	32.4	32.5	32.2	28.4	27.4	27.9	26.4
Hydrogen.	4.6	5.6	13.1	15.1	3.5	2.7	5.6	7.9	60.9	56.3	56.6	10.0	10.8	33.1	35.0	33.5	31.4	29.8	31.6	31.0	28.4	29.5	33.6	30.1	31.6	32.6
Methane.	10.5	14.2	51.8	54.0	14.8	14.4	15.0	15.0	8.3	18.3	20.3	68.2	66.1	9.2	12.9	15.0	17.6	23.5	13.2	16.4	19.7	20.9	18.6	18.5	15.3	17.5
Ethane.	1.2	2.0	—	—	—	—	—	—	9.8	6.3	4.7	1.3	1.4	0.9	1.0	2.3	2.5	0.0	3.0	1.5	0.3	0.0	—	1.9	3.5	2.9
Nitrogen.	68.7	62.4	0.6	0.1	2.9	3.1	5.1	2.9	4.8	4.1	3.3	2.0	3.5	3.2	3.3	2.1	2.3	2.7	3.6	2.7	3.3	3.0	1.4	3.5	3.8	3.6
Constituents Formed per Gallon Oil.																										
Cu. Ft. Illuminants.	25.6	27.0	19.4	18.15	28.36	27.25	30.0	29.8	24.5	26.0	25.2	27.0	28.9	19.4	27.6	30.0	29.8	27.4	27.40	27.37	26.46	25.81	28.2	29.5	27.4	26.4
Cu. Ft. Carbon Monoxide	2.6	1.6	1.25	1.06	3.39	2.96	-5.0	-2.9	2.9	1.0	2.0	3.3	1.8	+0.6	-1.1	+1.4	-0.6	-1.1	-1.51	-0.50	+1.17	+1.56	+0.6	-0.2	+0.9	-0.8
Cu. Ft. Hydrogen	8.5	10.6	8.2	10.0	6.71	5.04	0.3	8.1	+3.1	+20.6	+17.8	8.1	10.2	-3.4	-6.4	-6.0	-9.1	-11.4	-8.08	-8.10	-12.10	-9.18	-3.2	-9.1	-6.1	-2.7
Cu. Ft. Methane	21.3	27.0	32.42	35.8	30.29	29.05	30.2	28.2	13.3	32.3	36.9	17.4	17.2	13.8	21.9	26.8	32.3	44.9	26.00	32.52	39.80	44.04	36.2	36.5	29.6	35.4
Cu Ft. Ethane	2.4	1.0	—	—	—	—	—	—	19.4	12.6	9.4	0.2	—	1.6	1.9	4.5	4.9	0.0	6.18	3.08	0.62	0.0	—	3.8	7.0	6.0
B.T.U of Illuminants	2370	2260	2260	2580	2330	2410	2090	2200	2090	2020	2160	2466	2585	2670	2492	2243	2015	2211	2370	2370	2405	2320	2541	2440	2342	2373
Candles of Ill	—	—	—	—	—	—	1.43	1.30	1.93	1.90	1.89	2.00	1.95	1.80	1.86	1.90	1.85	1.72	1.98	2.01	2.01	1.93	1.84	1.78	1.83	1.80
Sp Gr of Illuminants	1.162	1.182	1.118	—	1.170	1.100	1.151	1.203	0.985	0.974	0.965	1.037	1.098	1.279	1.245	1.273	1.189	1.158	1.200	1.192	1.040	1.025	1.382	1.010	1.010	0.988

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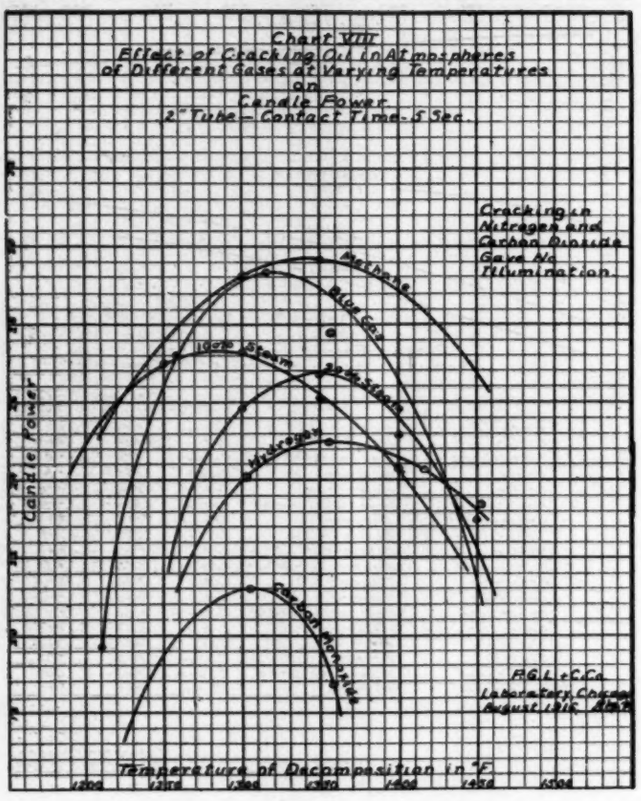
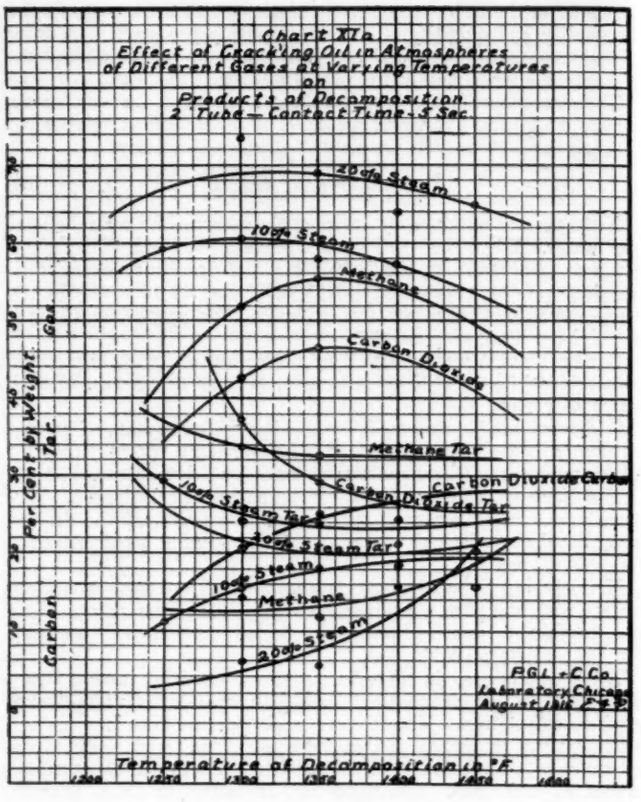


Chart VIII
Effect of Cracking Oil in Atmospheres of Different Gases at Varying Temperatures on Candle Power
2" Tube—Contact Time-5 Sec.
Cracking in Nitrogen and Carbon Dioxide Gave No Illumination.
Methane
Blue Gas
10% Steam
20% Steam
Hydrogen
Carbon Monoxide
Candle Power
P.G.L. & C. Co. Laboratory, Chicago August 1916
Temperature of Decomposition in °F.



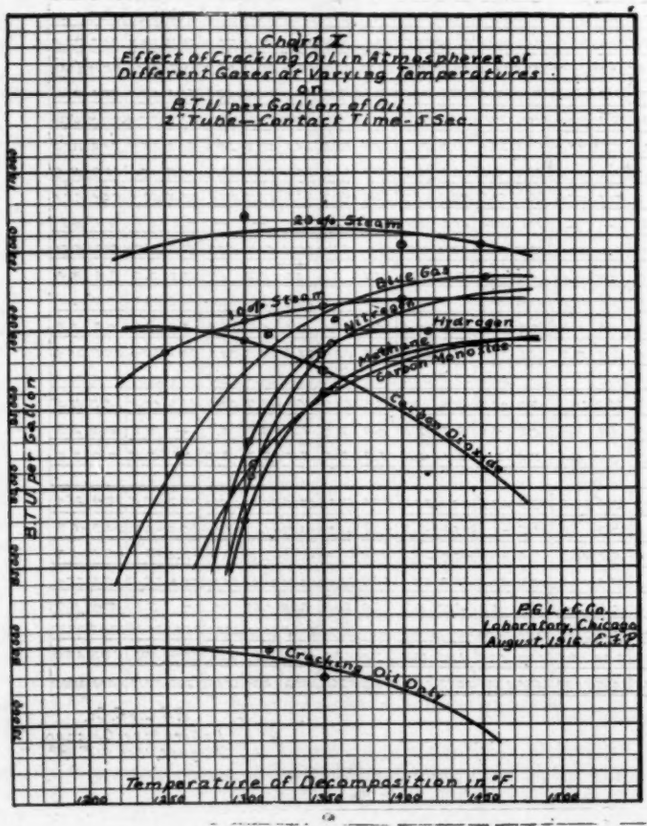
to the cracking furnace. When the bottom of the flash boiler was heated to a dull red the rate of steam generation could be closely regulated by properly adjusting the burette cock. Knowing the amount of water introduced, in proportion to the oil and the blue gas, it is an easy matter to calculate the percentage of steam and the time of contact.

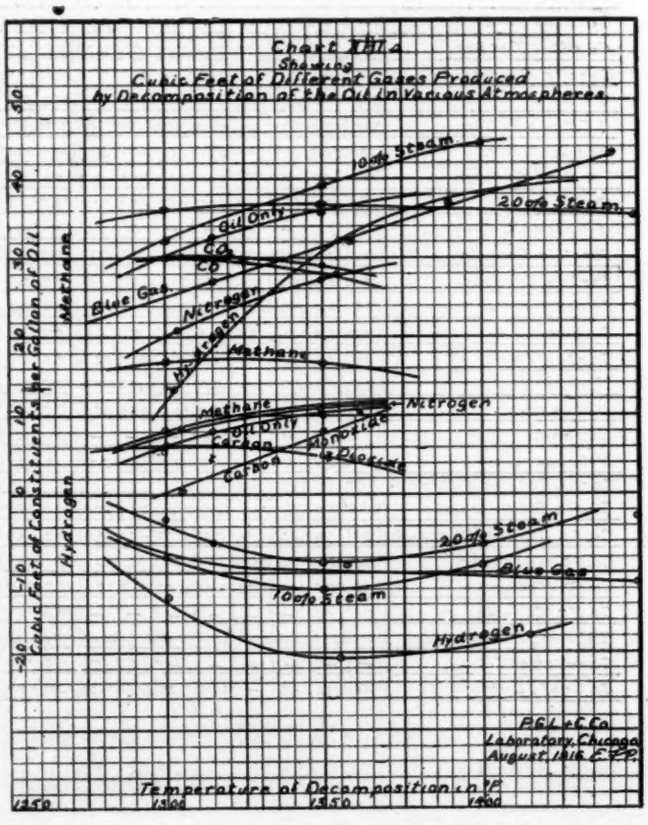
Analyses of the various gases are shown in Table II. It will be noted that the carbon monoxide, hydrogen and methane, contain considerable amounts of impurities. On the whole, these impurities are probably not sufficient to observe the main reactions and render the interpretation of results faulty.

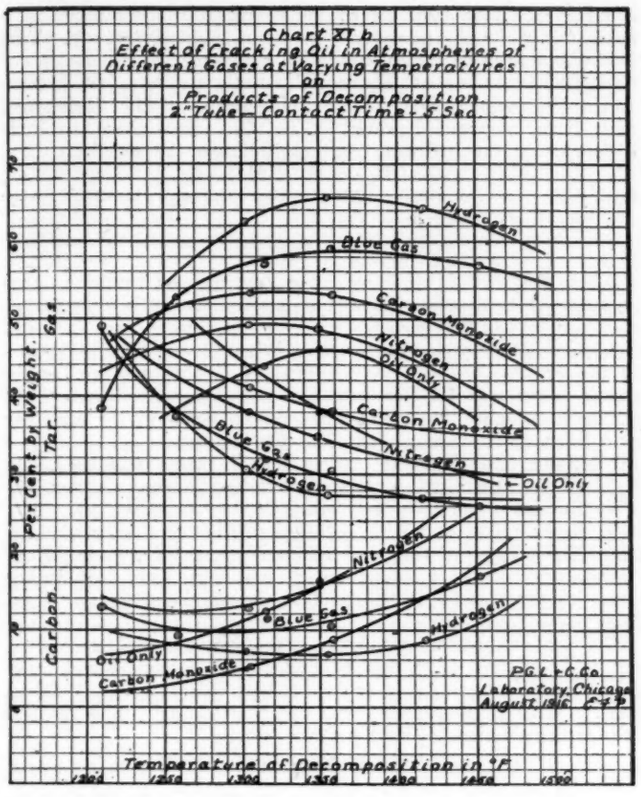
The results of the tests made with these different atmospheres are contained in Table III and also on the charts following.

Nitrogen

The tests were made in nitrogen to determine the effect of a neutral atmosphere. Since nitrogen is very inert, it is reasonably certain that no chemical decompositions other than those similar







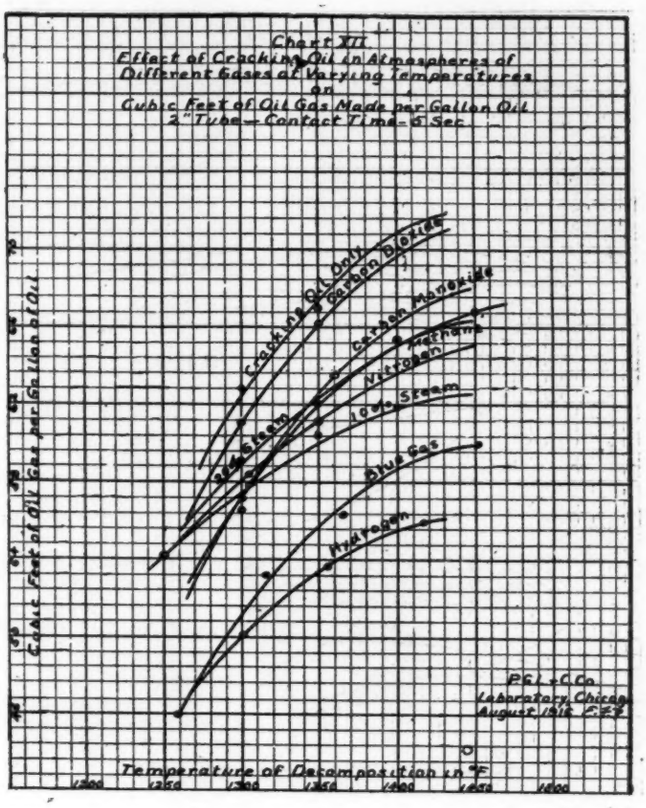


Chart XII
Effect of Cracking Oil in Atmospheres of Different Gases at Varying Temperatures on Cubic Feet of Oil Gas Made per Gallon Oil
2" Tube — Contact Time - 5 Sec.
Cubic Feet of Oil Gas per Gallon of Oil
Cracking Oil Only
Carbon Dioxide
Carbon Monoxide
Methane
Nitrogen
10% Steam
20% Steam
Blue Gas
Hydrogen
P.G.L. & C. Co. Laboratory Chicago August 1916
Temperature of Decomposition in °F

to the formation of straight oil gas will occur. At the same rate of oil introduction the time of contact will be much less when a foreign gas accompanies the oil vapors through the machine. For example when oil is introduced in to the cracking zone at the rate of 5 cubic centimeters per minte the time of contact will be about 16 seconds. When a carrier for the oil vapors is employed to make the proportion of oil gas in the finished gas about 30 per cent, the time of contact will be about 5 seconds. This will have a material effect upon the results and will be considered under the heading "Oil Only."

No candle-power results could be obtained when the oil was cracked in a nitrogen atmosphere since the gas would not burn in the Bray burner.

The B. t. u. obtained in the gas per gallon of oil (Chart X) is 97,000 at 350 deg. Fahr. This is slightly better than that produced in atmospheres of carbon monoxide, carbon dioxide and methane, and lower than that produced in hydrogen and blue gas.

The weight of oil gas produced (Chart XI-*b*) is rather low. This is to be expected since a greater decomposition of the oil gas would take place due to the absence of an active agent to retard such decomposition or to cause hydrogenation.

The tar and carbon produced on the other hand is quite considerable. This is generally the case in inert atmospheres.

The volume of gas made at 1,350 deg. Fahr. is about 62 cu. ft. per gallon of oil. It is to be noted also that the production of hydrogen at this temperature is 10.6 cu. ft., whereas when hydrogen is present in the surrounding atmosphere a disappearance or absorption occurs.

When oil is conducted into the cracking chamber, in the absence of any surrounding atmosphere, the effect of a longer time of contact and greater concentration of oil vapors can be clearly seen. The candle-power cannot be read accurately on a Bray burner since the gas burns with a large smoky flame and the maximum efficiency of the flame is not developed.

The B. t. u. per gallon is very low. Only 80,000 B. t. u. were obtained from the same oil which gave 97,000 when accompanied by nitrogen. This fact illustrates the tendency of the oil gas to decompose into simpler compounds and carbon. It will also be noted from Chart XII that a much higher yield of gas is obtained by volume. This gas is largely methane. Chart XI-*b* shows that the weight of oil gas found is small while the tar formation is exceedingly high.

A comparison of the results from cracking in the presence of nitrogen and cracking oil alone, as illustrated on Chart XIII-*b* shows that the illuminants are very easily decomposed with the formation of methane. At the temperature of 1,300 deg. Fahr., the illuminants decreased in volume from 25 ft. to 19 ft. due to the increased time of exposure. If the illuminants are considered to be mostly ethylene, the reaction occurring may have been

$$C_2H_4 = CH_4 + C_2.$$

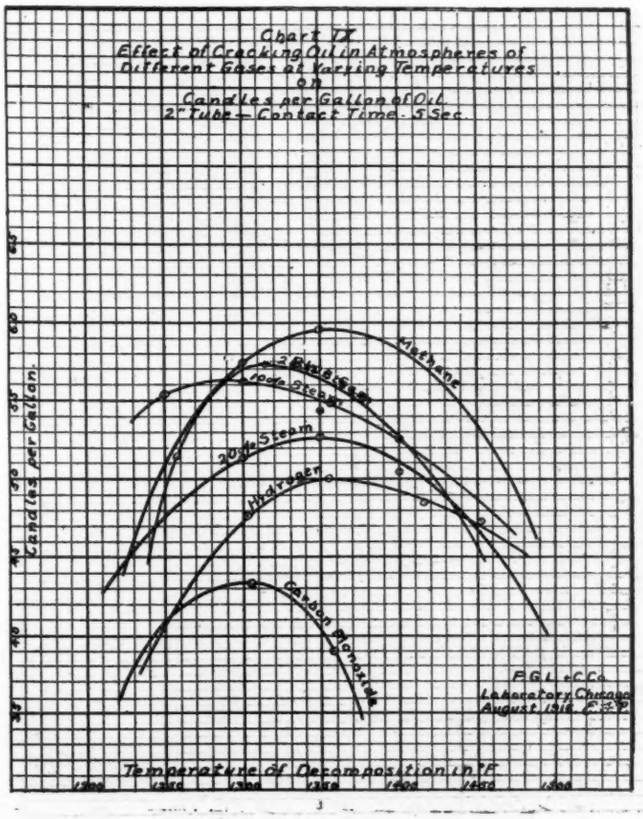
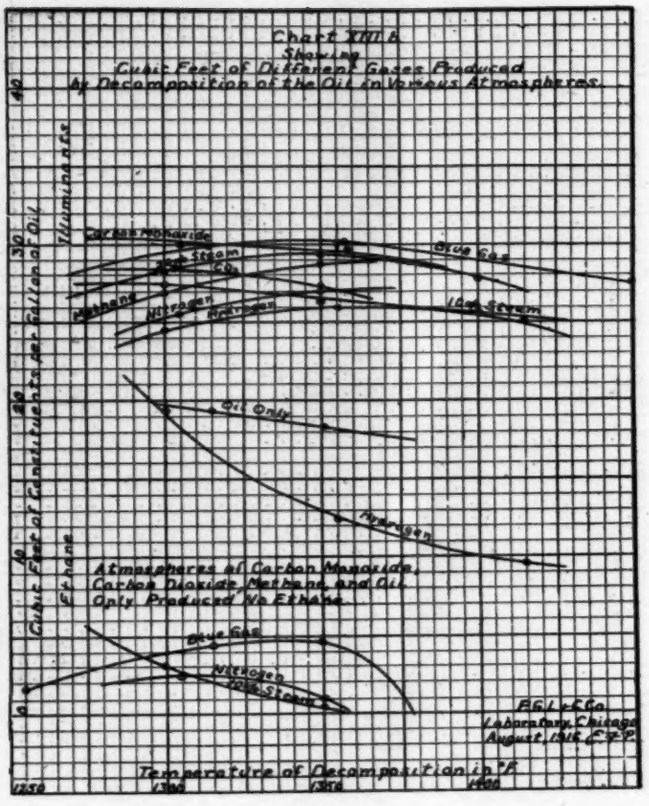


Chart IX
Effect of Cracking Oil in Atmospheres of Different Gases at Varying Temperatures on Candles per Gallon of Oil
2" Tube — Contact Time - 5 Sec.
Candles per Gallon
Methane
10% Steam
20% Steam
Hydrogen
Carbon Monoxide
P.G.L. & C. Co. Laboratory Chicago August 1916
Temperature of Decomposition in °F



This being true we would expect an increase in methane in the case of cracking the oil alone by about 6 cu. ft. Ethane when present in gas is equivalent to twice its volume of methane and its probable decomposition to methane is affected by hydrogen thus,

$$C_2H_6 + H_2 = 2CH_4.$$

Considering the volume of ethane as two volumes of ethane as two volumes of methane, the increase in methane content at longer time of contact is 7 cu. ft. The volume of hydrogen does not change.

Again at 1,350 deg. Fahr., the decrease in illuminants is 9 cubic feet while the increase in methane is about 8 cu. ft. This fact would seem to indicate that the reaction

$$C_2H_4 = CH_4 + C_2$$

is the predominant one. Some condensation of the illuminants may have occurred however. The fact that there is little difference in the hydrogen content indicates the reaction

$$CH_4 = C + 2H_2$$

does not occur to any extent at these temperatures and under the conditions imposed.

Carbon Dioxide

When the fires in the generator are in poor condtion large amounts of carbon dioxide will be produced. It is known that each per cent of the carbon dioxide in the finished gas decreases the candle-power by about 2 per cent. When the oil was decomposed in the presence of such a poor quality of blue gas the loss in candle-power was 5.5 per cent for each per cent difference in carbon dioxide in the finished gas, or 3.6 per cent for each per cent difference in carbon dioxide in the blue gas.

When an atmosphere of carbon dioxide alone was used, the candle-power could not be measured with the Bray burner, because the gas would not burn when issuing from the jet. The B. t. u. per gallon of 95,000 is less than that obtained with blue gas. The volume of the gas made was good, being over 60 cu. ft. per gallon. This gas, however, was very light, containing much hydrogen and methane, so that the weight of gas produced from the oil was low.

The tar production was lower than that obtained with blue gas or hydrogen. The noticeable effect of carbon dioxide was the increased production of carbon (Chart XI-a). At 1,350 deg. Fahr. a yield of 25 per cent was observed while in blue gas the ordinary production is about ten per cent.

Carbon Monoxide

The cracking of oil in a carbon monoxide atmosphere gave rather surprising results. The great loss of candle-power is noticeable. This is in accordance with the investigation of Dr. Elliot on "The Effect of Diluents on Candle-power."

The candle-power was low because of the effect of the large proportion of carbon monoxide in the finished gas and it would necessarily follow that the candle per gallon results would also be inferior.

The B. t. u. results (Chart X) were the lowest obtained with any atmosphere, excepting, of course, oil acting alone with a much longer time of contact. The volume and weight of gas

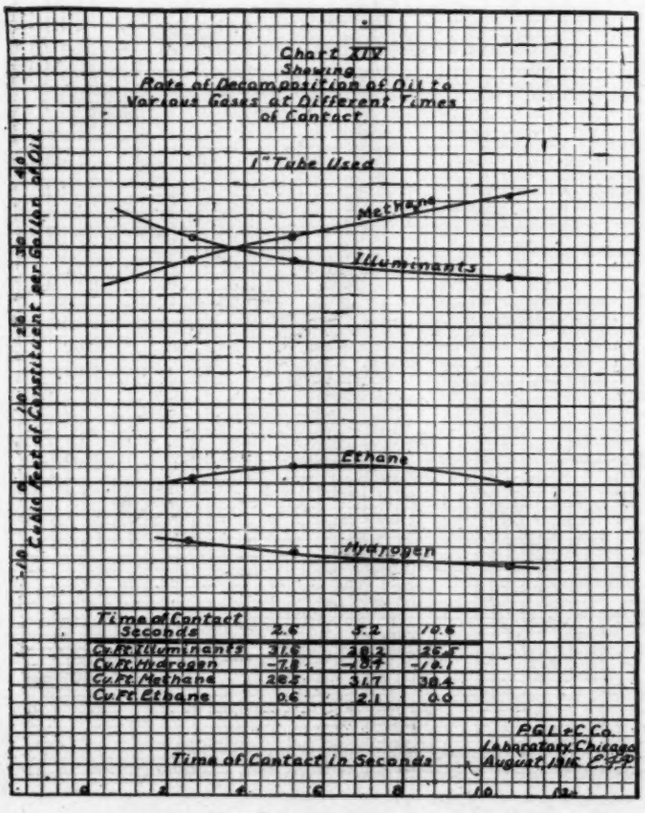


Chart XIV
Showing
Rate of Decomposition of Oil to
Various Gases at Different Times
of Contact.
1" Tube Used
Methane
Illuminants
Ethane
Hydrogen
Cubic Feet of Constituent per Gallon of Oil
Time of Contact Seconds | 2.6 | 5.2 | 10.6
Cu Ft Illuminants | 31.6 | 30.2 | 26.5
Cu Ft Hydrogen | -7.8 | -8.7 | -10.1
Cu Ft Methane | 28.5 | 31.7 | 38.4
Cu Ft Ethane | 0.6 | 2.1 | 0.0
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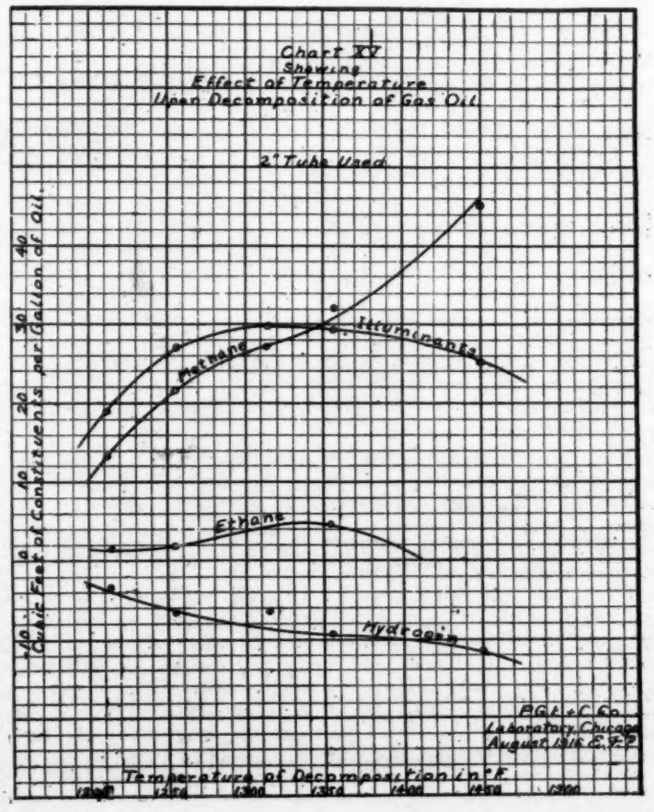
Time of Contact in Seconds



produced are good, being much better than the results with carbon dioxide or nitrogen.

Carbon monoxide appears to be a direct cause for the production of tar, since more tar was produced in this atmosphere than any other (Chart XI-*b*). The carbon depositions on the other hand are low.

It also appears that the carbon monoxide is instrumental in preserving the illuminants from decomposition (Chart XIII-*b*). Less hydrogen was generated in cracking the oil in carbon monoxide and the yield of illuminants was good.

A theoretical consideration of the action of carbon monoxide and dioxide upon the preservation of the illuminants and hydrocarbons leads one to expect that the results should be similar to what were actually obtained. For example take the reaction:

$$C_2H_4 + 2CO_2 = 4CO + 2H_2.$$

The conditions of equilibrium are expressed by the equation

$$K = \frac{p.\ CO^4 \times p.\ H_2{}^2}{p.\ C_2H_4 \times p.\ CO_2{}^2}$$

It is evident, since K, the equilibrium constant, has a definite value for each absolute temperature, and since the partial pressure of any constitutent is proportional to its volume, that the conditions favorable to preserving or preventing decomposition of the ethylene will exist when the volumes of carbon monoxide and hydrogen are higher and the volume of carbon dioxide is low. Now an examination of the results obtained at 1,350 deg. Fahr. shows that in carbon dioxide 28.2 cu. ft. of illuminants were produced, while in carbon monoxide 30 cu. ft. were made from a gallon of oil. Thus it will be seen that carbon monoxide does exert a preservative effect on the illuminants.

It appears possible also that the carbon monoxide is instrumental in aiding the oils to decompose more extensively into high molecular weight olefines, which pass into the tar, and ethylene or propylene, which increases the percentage of illuminants in the gas.

The effect of mass action is also noticeable in the carbon monoxide atmosphere. The presence of large amounts of carbon monoxide results in a slight absorption of that gas. In other atmospheres there was usually a small production of carbon monoxide. The probabilities are that carbon monoxide in solution in the water of the holder or meters is the contributing cause for this production. But it has also been demonstrated by Whitaker that cuprous chloride solution will absorb such paraffine hydrocarbons as ethane, propane and butane. This absorption would be indicated as carbon monoxide in an analysis and no doubt often accounts for the presence of carbon monoxide in the gas made.

When an atmosphere of carbon dioxide was used, however, some of the carbon dioxide was decomposed, for an absorption of 4 cu. ft. per gallon of oil was noticed. This absorption was accompanied by a production of 3.4 cu. ft. of carbon monoxide which is in accordance with the equation cited.

There are usually so many reactions taking place and so many equilibrium conditions to be considered in connection with oil decomposition that it is almost impossible to predict just what the ultimate outcome will be, whereas if only one reaction were to be considered it would be a comparatively easy matter.

Hydrogen

The action of hydrogen is the most interesting of all the gases examined. It was expected that candle-power and candle per gallon results would be high. As a matter of fact these results were lower than those obtained in an atmosphere of blue gas containing about 50 per cent hydrogen. The volume of gas made is high. This is an indication that absorptions have taken place. From Chart XIII-*a* it is seen that an absorption of hydrogen has actually occurred amounting to as high as 20 cu. ft. per gallon of oil. This absorption has resulted in the formation of saturated compounds, such as ethane and methane.

The production of illuminants (Chart XIII-*b*) is seen to be low. Apparently some of the unsaturated compounds have been hydrogenated forming saturateds. The reactions occurring are probaby

$$C_2H_4 + H_2 = C_2H_6,$$
$$C_2H_4 + 2H_2 = 2CH_4,$$

the latter occurring at high temperatures, the former at lower ones.

The illuminants have approximately the same photometric value as those produced in atmospheres of blue gas. The heating value of the illuminants is slightly lower. This would seem to indicate that hydrogenation of the higher olefines such as propylene and butylene occurs first, and that ethylene is more stable, being able to withstand decomposition. Further evidence tending to establish this theory is the fact that the specific gravity of the illuminants produced is lower and very close to that of propylene. Since all the errors of the analysis enter into this calculation it is probable that the results are a trifle low.

Hydrogen has an influence in producing high B. t. u. gas, because of the great production of saturated compounds. The decrease in the volume of gas made is the reason that the B. t. u. per gallon is not higher (Chart X).

Again when excessive amounts of hydrogen are present the tar production is lowered, also the amount of carbon deposited. The decrease in tar formation is probably caused by greater hydrogenation of the lighter olefin compounds which ordinarily would have passed into the tar.

Methane

When the oil was cracked in an atmosphere of methane the best candle-power results were obtained. This may be due to the fact that methane itself possesses a candle-power of 4.5 when burned at the rate of 5 cu. ft. per hour. The volume of gas made compares favorably where no absorption occurred. Hence the candle per gallon figures are also good.

As a whole, methane acts very much like an inert atmosphere, such as nitrogen or carbon monoxide, since the weight of tar and carbon produced is quite large. The effect of mass action is also seen in Chart XIII*a*. It will be noticed that much less methane was produced from the oil when the methane was already in the surrounding atmosphere. On the other hand the production of hydrogen is larger, an indication that the reaction

$$CH_4 = C + 2H_2$$

is occurring more extensively than in other atmospheres.

The effect of methane on the illuminants is also probably preservative, since the presence of this gas introduces equilibrium conditions which prevent the hydrogenation of the unsaturated compounds.

Blue Gas

A comparison of the action of the various atmospheres discussed, with that of blue gas, leads one to the conclusion that no advantage is to be gained over blue gas by the use of any of these atmospheres alone. It would not be beneficial to pass a scrubbed coal or oven gas through the carbureter or superheater while enriching with oil, neither would a natural gas used in such a manner add enough gain in the efficiency of oil cracking to offset the cost of such a procedure.

It is of much interest to note that blue gas, when used, gave much better candle-power results than either hydrogen or carbon monoxide alone. The lower proportions of carbon monoxide in the finished gas greatly diminish the deleterious influence of that constituent on candle-power, while the smaller proportion of hydrogen present decreases the loss of volume due to absorptions. The tar formation is lowered and carbon depositions are medium. The B. t. u. results are also greater than those obtained in any single atmosphere.

It is rather difficult to trace the reactions which have occurred in the carbureting of water gas. Charts XIV and XV are reproduced to show the general tendency of decomposition, *viz.*, the effect of increasing temperatures and also of increased times of contact on the production of the various constituents. It is to be noted that the illuminants formed from a gallon of oil gradually increase and reach a maximum at about 1,300 or 1,350 deg. Fahr. Higher temperatures cause the decomposition of these illuminants.

It is generally conceded by all authorities that when an oil dissociates the primary products are the higher molecular weight olefines and lower molecular weight paraffines. Further decomposition results in the production of carbon and hydrogen. For example we may assume decane ($C_{10}H_{22}$) to decompose as follows:

$$C_{10}H_{22} = C_9H_{18} + CH_4$$
$$C_9H_{18} + H_2 = C_9H_{20}$$
$$C_9H_{20} = C_8H_{16} + CH_4$$

or in general

$$C_nH_{2n} + 2 = C_{n-1}H_{2n-4} + CH_4$$
Paraffine = Olefine + Paraffine

$$C_{n-1}H_{2n} - 2 + H_2 = C_{n-1}H_{2n}$$
Olefine + Hydrogen = Paraffine

$$C_{n-1}H_{2n} = C_{n-2}H_{2n-4} + CH_4$$
Paraffine = Olefine + Paraffine

A consideration of the results in Chart XIV will show that this reaction has taken place extensively. The illuminants which consist mostly of ethylene are hydrogenated, forming methane and some ethane. The longer the vapors are acted upon the greater is the proportion of methane produced and the hydrogen absorbed, while the illuminants decrease. On the other hand such reaction as

$$CH_4 = C + 2H_2$$

did not occur to a marked extent, since if this had happened one would expect an increase in the hydrogen present in this oil gas. The volume of hydrogen formed should have been noticeable, whereas there was always an absorption. Extremely high temperatures favor the latter reactions, however.

From the work with blue gas it is difficult to state whether oil decomposes with the formation of hydrogen. This is probable but the amount present in the finished gas is usually less than that in the blue gas. At temperatures above 1,500 deg. Fahr., the reverse has been noted, and is probably due to the decomposition of methane to carbon and hydrogen. The hydrogen absorption varies from 6 to 10 cu. ft. at the usual temperatures of operation.

As has been already noted methane is the main primary decomposition products of the oil formed by hydrogenation of olefines. It gradually increases until temperatures above 1,600 are reached.

Ethane is also a primary decomposition product but we rarely obtained more than 5 cu. ft. per gallon. The usual temperature of formation was from 1,250 to 1,350 deg. Fahr. At 1,400 deg. Fahr. the ethane has all decomposed, probably according to the reaction

$$C_2H_6 + H_2 = 2CH_4.$$

The disappearance of the ethane is usually accompanied by a large increase in methane content. The reactions

$$C_2H_6 = C_2H_4 + H_2$$

and

$$C_2H_6 = C_2H_2 + 2H_2$$

do not occur extensively as some have believed, since if this were true one would expect a larger increase in illuminants and hydrogen than was actually found. These reactions do occur to some extent at higher temperatures and longer times of contact than are usual in operating practice. As a matter of fact increasing times of contact result in greater hydrogen absorptions and a decrease in illuminants. This indicates that the conditions are not suitable to ethylene formation.

The Effect of Steam

Steam is always present in the blue gases passing through the carbureter and superheater, especially at the end of the run. The steam exerts a detrimental effect on candle-power and candle per gallon results, as can be seen from Charts VIII and IX. The B. t. u. per gallon of oil produced is high. This may be due to a partial decomposition of the steam into hydrogen, since the weight and volume of oil gas produced is greater than that in blue gas without steam. Steam also gave lower yields of tar and larger carbon depositions. Much reliance can not be placed on these figures, however, since the weight of water used was deducted from the total weight of tar and water condensed. Irregularities in the drawing of the tar greatly effect the results and also some decompositions of the steam occurred.

A consideration of the theoretical equation

$$C_2H_4 + 2H_2O = 2CO + 4H_2$$

and the equilibrium conditions connected with it leads one to expect that an excess of steam would cause a decomposition of hydrocarbons. Such has been the case. At 1,300 deg. Fahr. about 30 cu. ft. of illuminants were produced in the dry blue gas. The same temperature with finished gas containing 10 per cent of steam yielded only 27.4 cu. ft. of illuminants. When 20 per cent steam admixed with blue gas was used, 28.2 cu. ft. of illuminants were produced.

The higher percentage of steam also seemed to allow the maximum production of illuminants to occur at a slightly higher temperature. The ethane did not dissociate so rapidly when more water vapor was present. Apparently the presence of excess steam is not injurious to the operation of a water gas set from a B. t. u. standpoint, but it is decidedly so from a photometric point of view. Besides the presence of much steam is an indication of poor blue gas and longer times of contact, all of which are very injurious to good operating results.

Appearance of Flames

The appearance of the flames when the gas formed in the various atmospheres was burned in the Bray burner is no doubt of interest. Carbon monoxide causes the flame to be small and very bright. Hydrogen causes the flame to be large and unsteady, but not very brilliant. Methane gave a very large flame but rather deceiving as the candle-power was not as high as might be expected from casual observance. No appreciable difference could be noticed in the burning of the blue gas—oil gas flame from that of blue gas steam—oil gas.

Large Proportion of Consumers Using Small Amounts of Gas per Month Significant

The very large proportion of gas consumers who are using small amounts of gas each month is very significant, and in general, it would seem that the gas utilities have not given sufficient attention to this condition, asserted W. G. Vincent, Jr., in a paper presented at the recent annual convention of the Pacific Coast Gas Association at Santa Barbara, Cal. I believe it would be well worth while for every gas utility to make a thorough analysis of all of its small consumers, in order to determine first how many are dead weight; that is, who will never require any more gas than they are now using, and, second, how many are potentially larger consumers.

Concerning each consumer in this latter class there should be secured full information as to their present use and possible future requirements. Such an analysis could be made at a very small cost per consumer, and would enable the utility to handle solicitation for additional business, through the mail and otherwise, in the most efficient manner.

Still further importance is added to the large proportion of small consumers, if we plot the cost of supplying gas, and, assuming the rate as $1.00 per 1,000 ft., plot the revenue per consumer. We can then see that all consumers using less than 2,400 ft. per month are being served at less than a fair return and that 70 per cent of the consumers using 38 per cent of the total gas sold are in this class.

It is interesting to note in this connection that in the Milwaukee Gas Case the Wisconsin Commission found that 70 per cent of the consumers were being served at less than cost.

Encouragement from Idaho

Some of our people are given to look upon commissions as enemies to their interests, states Samuel Insull in a recent address, but I have a case (an extract from a decision) from a part of the country not supposed to be favorable to corporate interests. I refer to the state of Idaho. A few months ago the Idaho Public Utilities Commission handed down a decision in a case, in which, speaking of the rate of return, the following statement was made:

> **"This commission will not be placed in a position of stifling ambition and effort in the development of public-utility enterprises by adopting a fixed per centum as the rate of return which a utility shall be allowed on its investment. The rate of return will be determined in each individual case, giving due consideration to efficiency and economy in management, and thus afford a stimulus for the utility to increase its business, to reduce its operating expenses and thereby reduce the cost of the commodity to the consumer. If a public utility can by efficient management reduce the operating expenses below the ordinary amount, or if it can by the application of a broad and public-spirited policy develop a community and thereby develop its business and increase its earnings, it is certainly entitled to share in the increased earnings directly resulting therefrom. We believe that the application of this policy will create an incentive to greater and more efficient effort on the part of the investor and that it will redound to the benefit of the community served as well as of the entire state. The commission finds that eight per cent per annum is a reasonable rate of return on the investment now under consideration."**

News of the Gas Industry

Bangor, Maine, Has Opportunity for Better Lights

The Bangor Gas Light Company has offered to provide street lights along the lines of its mains at about $28 per lamp per year. A demonstration of the lights is being made by the company.

Jenkintown, Pa., to have New Gas Office

The plans for the new office building of the Philadelphia & Suburban Gas Company are practically completed. The building will be erected at Jenkintown, Pa., and will be three stories, stone, as designed by L. V. Boyd, architect.

Educational Publicity

The Minneapolis Gas Light Company of Minneapolis, Minn., has prepared a moving picture film, 1,000 ft. long, showing the complete manufacturing process of their gas from the coke pile to the illuminating fixture. The company which serves 82,000 customers realizes the value of the educational factor and is making use of it.

Lower Rates Offered to Large Consumers at Independence, Mo.

The Jackson County Light, Heat & Power Company has submitted a rate schedule to the Missouri Public Utility Commission which offers to supply gas at $1.15 net for the first 5,000 cu. ft.; $1.00 for the second 5,000 cu. ft., and 85 cents for all over 10,000 cu. ft. As the consumers are now paying $1.15 net, this does not decrease the present initial charge, but it makes a decrease in the subsequent charges that will greatly benefit the large consumers.

Keokuk, Iowa, Has Bad Explosion

An explosion in the purifier room of the Keokuk Gas Company's plant resulted in the death of two men, one being the foreman and another a workman. A hole had to be dug through the foundation of the building and a rescuing party equipped with oxygen helmets were sent in to secure the bodies of the victims. The accident, it is said, was caused by a stoppage in the pipes.

Denver's Coke Pile Has Disappeared

The coke pile at the gas plant of the Denver Gas & Electric Light Company used to be something to shudder at, but it has now entirely disappeared because of popular demand, according to E. P. Gartland, superintendent of the gas plant. The Denver company has just finished a coke bin capable of holding 12,000 tons. During September this company sold 11,000 tons of coke.

Gas Engines Back Philadelphia's High Pressure Water

Once a year the Philadelphia Fire Department conducts a practical test of its high pressure water system to assure the officials that the entire system is in good working order. The United Gas Improvement Company takes a keen interest in these yearly tests as the high pressure is obtained by pumps driven by gas engines. They are naturally proud of the fact that there has never been a failure of these pumping stations in twelve years, to meet any emergency.

Charleston, S. C., Has Lower Gas Rate

The Consolidated Company of Charleston, S. C., has reduced the price of gas from $1.50 to $1.00 per 1,000 cu. ft. Although the cost of manufacturing materials has greatly increased, the company believes that the reduction will so increase the number of consumers as to make it advantageous. Several gas appliance sales campaigns have been carried through with marked success by the company and in anticipation of a large heating business this season the company has ordered two carloads of gas heaters, which are expected to arrive shortly. Another incentive toward better service is the work done by a woman demonstrator, who visits each range that is installed to determine whether it is giving standard satisfaction.

Auburn Company Expects Its Domestic Lighting Maintenance Department to be Self-Sustaining in Short Time

Recently the Empire Gas & Electric Company put into effect a new department to take care of domestic lighting under the name of House Maintenance. The photographs show one of the means used to bring the idea to the attention of the customers. Reading from left to right in the picture, a customer is shown who wishes to have her lights fixed up or perhaps has other trouble and is in the act of phoning the gas company. "Bell Service" brings her call to the switchboard and the operator transmits it to the proper departmennt and then the company's service is put in operation. The bicycle carries out the idea further indicating the link between the company and customer. Below is shown the suit cases the four House Maintenance men carry, and they contain practically everything used in connection with house lighting.

The company makes a flat charge of 10 cents per light per month for all lights except arcs. Each customer is visited at least once a month and oftener if called upon.

This system is entirely separate from the company's regular system of light maintenance in the business section and is expected to be self sustaining by Jan. 1, 1917.

The Ohio Cities Gas Company Plans Big Absorption

Plans are being perfected for a consolidation of the Columbus Producing Company, Columbus Oil & Fuel Company, and the Boone Royalty Company, with the Ohio Cities Gas Company, of which they are subsidiaries. The consolidation plan is in line with action to be taken by many large industrial corporations throughout the United States to effect saving in taxation. Under the present form of organization of the Ohio Cities and its subsidiaries, earnings of the subsidiaries are assessed under the income tax and then again assessed when paid as dividends to the Ohio Cities company. All the earnings of the three subsidiaries are thus taxed twice. A saving of about $50,000 this year is expected by the consolidation.

Old Colony Gas Has Good Report

The Old Colony Gas Company reports an output for October of 7,730,000 cu. ft. compared with 6,231,000 cu. ft. of the same month of the previous year, an increase of over 24 per cent.

Kansas Natural Gas Company Enters Into Contract

Stockholders protective committee of Kansas Natural Gas Company has sent notices to stockholders that a contract has been entered into with Henry L. Doherty & Co. of New York, providing that the latter will purchase all the $6,000,000 stock of the Kansas Natural Gas Company at $40 a share for shares of $50 par value and assume the expenses incurred by the stockholders' committee. The contract, however, is subject to securing a minimum of 40,000 shares.

Pawtucket, R. I., Receives Quarterly Revenue

The Pawtucket Gas Company has recently paid into the city treasury $1,401.33, which is 2 per cent of the gross earnings for the quarter ended September 30.

Wheaton, Ill., Opens New District Office

The Western United Gas & Electric Company recently took possession of its new central office building in Wheaton, Ill.

Everything has been planned for the best accommodation of customers and employees in every department of the building, and it is said to be one of the tastiest, roomiest and most sanitary constructed buildings outside of Chicago. The massive furniture and necessary equipment has been selected from a most modern standpoint.

The Northwestern district, of which Edward Garrity is manager, includes Wheaton, Lombard, Glen Ellyn, Winfield, West Chicago, Bensenville, Itasca, Ardmore, Warrenville, Bloomingdale and Roselle.

Societies and Associations

THE ILLUMINATING ENGINEERING SOCIETY AND THE AMERICAN ELECTRO-CHEMICAL SOCIETY held the third annual joint meeting of the New York Sections, Thursday evening, Nov. 9, in the Engineering Societies Building, New York City. The topic of the evening was Modern Gas Lighting. The several papers presented were as follows: "Some Notes on Gas Standards" by W. R. Addicks, vice-president Consolidated Gas Company of New York; "The Most Recent Development in Incandescent Gas Mantles," by Elmer L. Knoedler, general superintendent of the Welsbach Company.

THE ILLUMINATING ENGINEERING SOCIETY, Chicago section, held its November meeting Thursday, Nov. 9, in the Edison Building, Chicago, Ill. The speaker of the evening was Pfof. Morgan Brooks, of the University of Illinois, and the subject "The Growth and Importance of Illuminating Engineering."

THE NEW ENGLAND SECTION OF THE NATIONAL COMMERCIAL GAS ASSOCIATION held its sixth annual meeting at the Boston City Club, Oct. 27. The meeting was preceded by a banquet and directly after the members retired to the lecture room where the business meeting was opened by the retiring president, Mr. C. E. Paige. The report of the secretary-treasurer showed improvement, both financially and in membership over the previous year. The new officers are as follows: President, George P. Smith, Jr., Weymouth; vice-president, Fred K. Wells, Boston; secretary and treasurer, C. J. Connell, Boston; directors, C. E. Paige, A. A. Higgins, E. I. Goggin, S. E. Gillette, J. L. Murray, F. W. Jennings, M. C. Abbott, W. S. King, E. B. Mooney, J. C. D. Clark, Chas. T. Aaron, L. A. Sprague, L. W. Geffine, C. G. Stephens, R. A. Fancy, and Rollin Buckminster. A finance committee and a program committee were also appointed. The next meeting will be held at the City Club on Friday evening, Nov. 24.

Personal Notes

GEORGE N. ROOKER, manager of the Sand Point (Idaho) division of Northern Idaho and Montana Power Company, has been elected secretary and treasurer and also director, of the Sand Point Commercial Club.

H. C. HOAGLAND, manager of the Muskogee Gas & Electric Company, has been elected trustee for one year of the Lion's Club, recently organized at Muskogee, Mich.

CHARLES THAWLEY, superintendent of gas lights for the Bridgeport Gas Light Company, was found dead in his room, Nov. 2. The cause of his death was accidental.

Construction Notes

Elmhurst, Cal., Anxious for Gas

A petition signed by the householders of the Elmhurst district has been presented to the Pacific Gas & Electric Company, asking that the mains be extended to meet their requirements. As this will amount to several thousand dollars per year of new business, it is probable that the extensions will be made.

Bozeman, Mont., May Have Gas Plant

The City Council of Bozeman, Mont., is considering the calling of a special meeting of the taxpayers to vote on a gas franchise to be granted for 35 years. Robert W. Lysle of a Chicago firm has asked for the privilege of installing an artificial gas plant with the capacity to manufacture 50,000 cu. ft. of gas every 24 hours. It is promised that the plant will be operating 18 months after the franchise is granted and that the company will charge $1.80 for each 1,000 cu. ft. with a prompt payment discount.

Buffalo Citizens to Ask for Extension

The Polish Citizens Protective Association has decided to petition the Council to extend natural gas lines in the vicinity of Broadway and Person Street at Buffalo.

Progress on Main Construction at Endee Manor, Conn.

The Bristol & Plainville Tramway Company has completed the work on extending the mains and are now running the laterals to the houses. The same company is also laying gas mains to the new building tract of the Bristol Brass Company on King Street, Bristol.

Pottstown, Pa., Lines are Extended

The Philadelphia Suburban Gas & Electric Company is extending its lines across the Schuylkill River to Kenilworth and Cedarville in Chester County. These towns are helping to house Pottstown's increasing number of families due to industrial expansion.

New Equipment at Gardner, Mass., Will Triple Production

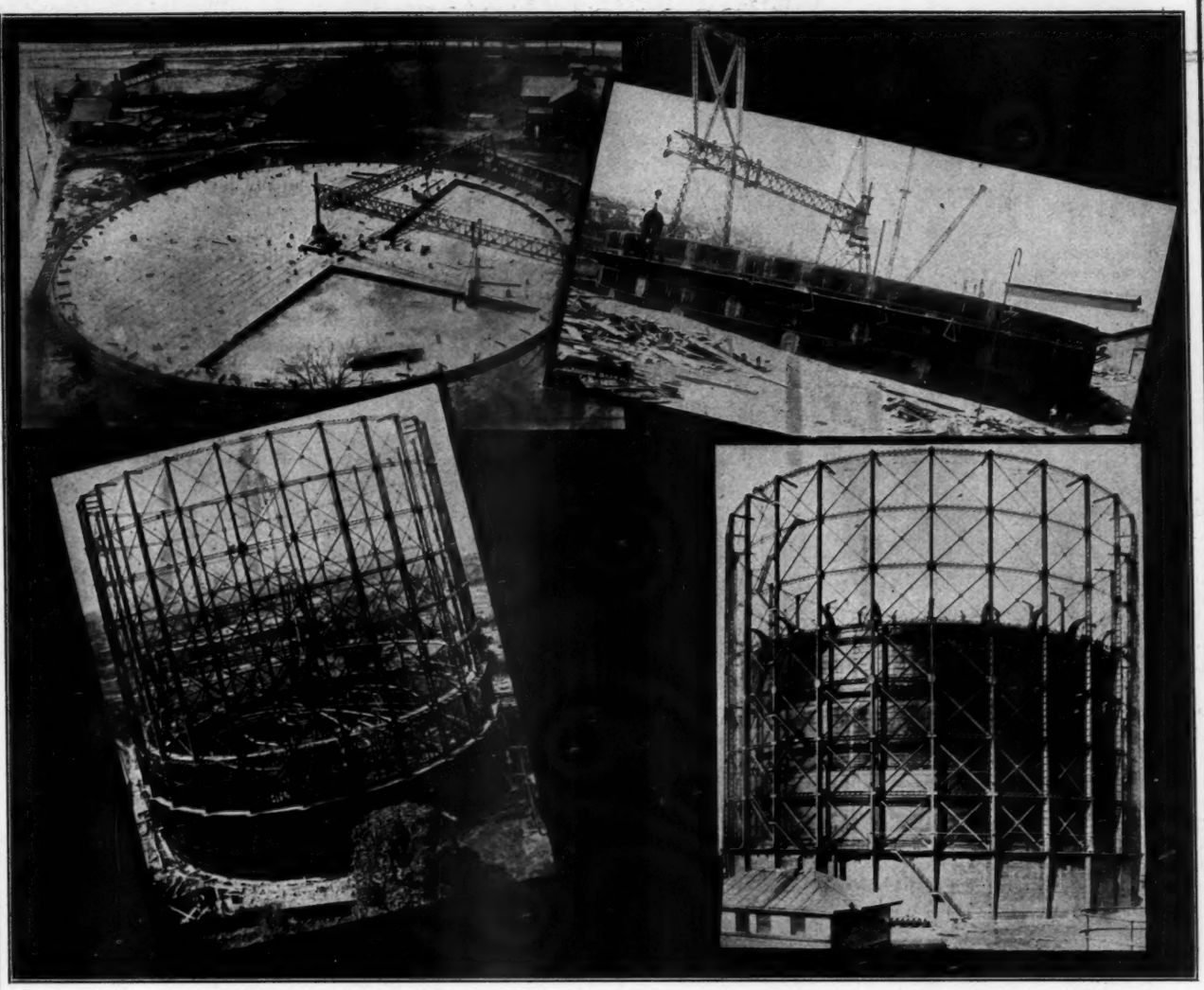
The Gardner Gas Light & Fuel Company is overhauling its generating plant and installing machinery which will increase its output from 4,000 to 12,000 cu. ft. The contract for overhauling the equipment and installing the new generator has been awarded to the United Gas Improvement Company, Philadelphia, and the construction work is being done by Smith & Townsend, Boston. The work is expected to be completed Jan. 1. As the rate to manufacturers has been dropped from $1.45 to $1.00 many large consumers have signed contracts with the gas company.

MARION, ILL.—The Southern Illinois Gas Company is soon to begin improvements on its newly purchased office building. Another story will be added, a fine front will be put in and an entirely new heating system installed.

BEVERLY, MASS.—The Beverly Gas and Electric Company has asked permission to open the following streets. Ellsworth Avenue, Corning Street and Abbott Street.

HOPKINS, MINN., recently voted gas bonds for $30,000. This money will be used to improve and enlarge the present gas plant.

SPRINGFIELD, MO.—The Springfield Gas & Electric Company has awarded the contract for the excavation for the new steam pipe line to be installed for the contral heating system of its building, to the Plummer-Adams Construction Company.



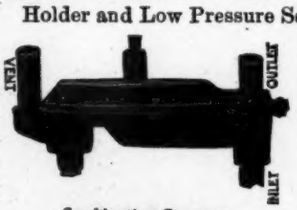
RITER-CONLEY COMPANY

STEEL CONSTRUCTION

PITTSBURGH

REYNOLDS GOVERNORS

We make anything desired in the GAS GOVERNOR or REGULATOR to meet any and all classes of reductions. Stations for DISTRICT SERVICE, INDIVIDUAL HIGH PRESSURE GOVERNORS for reducing high pressure gas to inches of water. Holder and Low Pressure Service Governors. A steady, uniform pressure can be obtained by using REYNOLDS GOVERNORS, "THE WORLD'S STANDARD." We make a specialty of the Governor business, devoting our entire time to the manufacture of same. All Governors are GUARANTEED.



Combination Governor
Governor and Mercury Seal

REYNOLD'S GAS REGULATOR COMPANY
ANDERSON, INDIANA. U. S. A.

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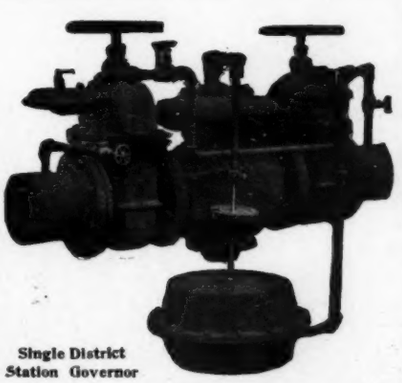

Single District
Station Governor

Financial Notes.

THE UNITED FUEL GAS COMPANY reports that gross earnings for the nine months ended Sept. 30, 1916, increased 38.7 per cent over the corresponding period in 1915 and net earnings increased 121.5 per cent. Fifty-one per cent of the stock of the company is owned by the Columbia Gas and Electric Company. The statement for September and for the nine months, with comparisons, follows:

For September—	1916	1915
Gross earnings	$302,099	$182,445
Net earnings	154,204	56,792
Interest	40,709	35,552
Surplus	113,495	21,240
For nine months ended Sept. 30—		
Gross earnings	$2,946,946	$2,124,673
Net earnings	1,668,537	921,056
Interest	348,652	325,194
Surplus	1,319,885	595,862

THE J. G. WHITE MANAGEMENT CORPORATION has declared the regular quarterly dividend (15th Quarter) of 1¾ per cent on the Preferred Stock of this Corporation, payable December 1, 1916, to stockholders of record November 18, 1916.

CANEY RIVER GAS COMPANY OF ILL. has declared a quarterly didivend of 2½ per cent payable November 20 to stockholders of record November 9.

THE UNITED GAS IMPROVEMENT COMPANY reports that the earnings of its subsidiaries continue to show large gains, and for the nine months ended Sept. 30 sales of gas of companies outside Philadelphia increased 6.4 per cent, and in the latter city 5.98 per cent over the corresponding nine months of 1915.

It has been seven years since United Gas Improvement made an increase in its stock capitalization, and it is being said that some time in the next year a distribution of stock may be looked for. The company has a capital stock of $55,500,000, and a surplus of $32,500,000, and it is believed that a part of this surplus may be distributed in the form of additional stock. United Gas Improvement owns one-third of the stock of Public Service Corporation of New Jersey, and on the 8 per cent rate now being paid on this stock receives about $800,000 a year from this holding. United Gas Improvement took its allotment of the new stock recently issued by Public Service corporation.

THE UNITED GAS & ELECTRIC CORPORATION reports for September gross earnings of the subsidiary companies $1,271,069, an increase of $135,952 over September, 1915; net earnings $565,378, an increase of $32,206; and balance after charges $308,217, an increase of $56,389. For the 12 months to Sept. 30 gross earnings were $14,804.865, an increase of $1,583,749; net $6,519,540, an increase of $881,198; and balance after charges $3,060.73, an increase of $777,461. Net earnings of United Gas & Electric from all sources for the year to Sept. 30 were $1,469,850, balance for dividends was $933,146, and balance after dividends on the first preferred was $283,210.

NORTHERN STATES POWER COMPANY'S gross and net earnings for the year ended Sept. 30, 1916, compared with corresponding previous year, are reported as follows:

Year ended September 30	1916	1915	Increase	% Inc.
Gross Earnings	$5,822,702	$4,933,575	$889,127	18.02
Net Earnings	3,233,956	2,742,469	491,487	17.92

WESTERN STATES GAS & ELECTRIC COMPANY'S gross and net earnings continue to increase. For the month of September there was an increase of 7.71 per cent in net earnings over September, 1915, and the increase in gross for the same period was 6.24 per cent. Comparative figures are as follows:

Month of September	1916	1915	Increase	% Inc.
Gross Earnings	$102,899	$96,854	$6,044	6.24
Net Earnings	49,926	46,350	3,576	7.71

THE TENNESSEE RAILWAY, LIGHT & POWER COMPANY'S combined gross earnings of all subsidiaries for nine months ended Sept. 30 were $3,583,929, against $2,844,901 for the corresponding period of 1915. Net was $1,640,276, increase $455,696. September gross earnings were $162,567, increase 71.7 per cent; net $65,847, increase 24.3 per cent.

THE SYRACUSE LIGHTING COMPANY has been authorized by the Up-State Public Service Commission to issue $100,000 6 per cent ten-year bonds, to be sold at par. Proceeds of this sale and $47,267 from bonds previously authorized will be used to reimburse the treasury of the company for expenditures for capital account in 1915.

THE WISCONSIN-MINNESOTA LIGHT & POWER COMPANY, a subsidiary of the American Public Utilities Company, reports gross income of $1,210,938 for the year ended June 30, compared with $1,055,894 the year before. The net income after interest charges had been met was $382,396, against $304,432 in 1915.

THE PACIFIC LIGHT & POWER CORPORATION of Los Angeles, Cal., reports for the twelve months ended August 31 last an increase in gross earnings of $303,450, as compared with those of 1915.

THE WESTERN STATES GAS & ELECTRIC COMPANY of Delaware has declared the regular quarterly dividend of one-half of one per cent on the common stock, payable November 15, to the stockholders of record of October 31. This announcement was made by H. M. Byllesby & Co. of Chicago.

Current Prices of Public Utility Securities

	Bid	Asked
Adirondack Elec. P	25	27
Adirondack Elec. P. pf	82	85
American Gas	120	123
*American Gas & Electric	152	155
*American Gas & Electric pf	49	51
American Light & Traction	382	385
American Light & Traction pf	110	113
American Power & Light	74	77
American Power & Light pf	84	86
American Public Utilities	40	44
American Public Utilities pf	72	75
American Water W. & Elec	9¼	9⅞
Amer. W. W. & E. 1st pf	67	70
Amer. W. W. & E. part'p pf	24	27
Carolina Pow. & Lt	29	32
Carolina Pow. & Lt. pf	97	100
Cities Service	315	318
Cities Service pf	92¼	94
Colorado Power	29	32
Colorado Power pf	100	104
Commonwealth, Pr. Ry. & Lt	61	63
Commonwealth, Pr. Ry. & Lt. pf	84	86
Electric Bond & Share pf	98	103
Empire District El. pf	90	95
Federal Light & Traction	16	18
Federal Light & Traction pf	55	60
Gas & Electric Securities	290	310
Gas & Electric Securities pf	95	100
Northern States Power pf	99½	101
North. Ont. Lt. & P	14	17
North. Ont. Lt. & P. pf	56	61
Ozark Power & Water	44	48
Pacific Gas & Electric	60	61
Pacific Gas & Electric pf	90½	92
Republic Ry. & Light Co	51	52
Republic Ry. & Light Co. pf	79	81
*Standard Gas & Electric	15½	16½
*Standard Gas & Electric pf	42¾	43¾
So. Cal. Edison	90½	93
So. Cal. Edison pf	106	109
Tennessee Ry., Light & Power	12¾	13¼
Tennessee Ry., Light & Power pf	52	53
United Light & Railways	49	51
United Light & Railways 1st pf	79	81
Western Power	17½	20
Western Power pf	70	72

*Par value $50